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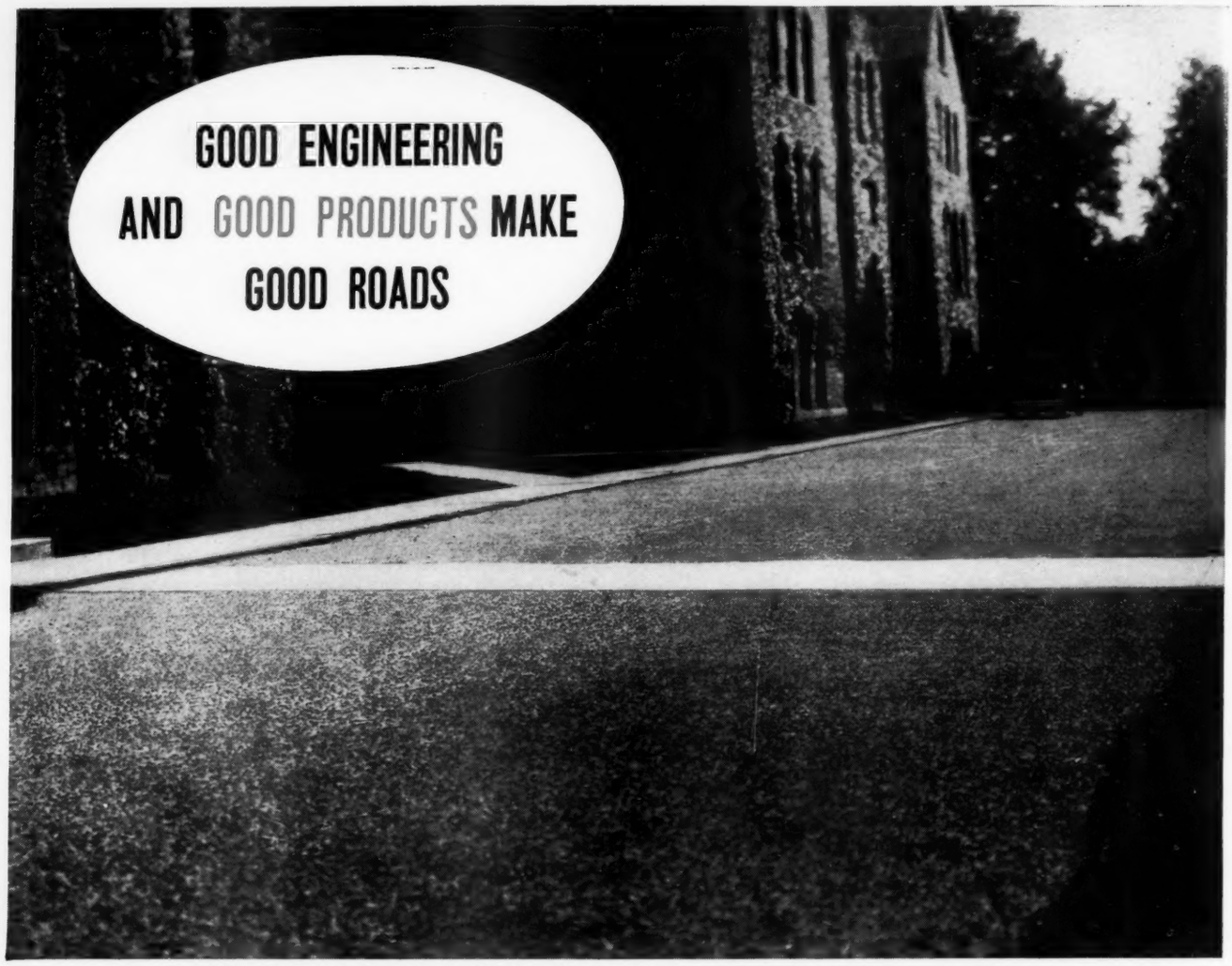

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VOL. 65 PUBLIC WORKS No. 7
Entered as second-class matter at the Post Office at New York, N. Y., Sept. 1, 1922, under the act of March 3, 1879.
Published Monthly by PUBLIC WORKS JOURNAL CORPORATION, 310 East 45th St., New York, N. Y.
SUBSCRIPTION RATES United States and Possessions, Mexico and Cuba, $3.00. All other countries, $4.00.
JUNE, 1934

July 1934

PUBLIC WORKS

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TIMEWASTERS

Some of the faithful have been writing in to know what this here Reaumur scale is. Well, R = 5/5 C = 5/9 (F-32). Maybe the USSR doesn't use it any more. The answer to Mr. Wheeler's problem is:

	F	C	R
Afternoon	+16	—8.88	—7.11
Night	+ 3.2	—16.	—12.8
Morning	—4.	—20.	—16.

The answer to Mr. Semmes' problem of the Florida chord is d = .2646. Being lazy, we did not work it out, but read it from curves for pipes flowing part full. Nice problem, though. Mathematician extraordinary, Benjamin Eisner, who has been in retirement in New Jersey of late, called up the other day to say that the correct answer to the SAP problem was 904.735 cubic inches, when worked on a machine. OK. To solve, prolong the can to form a cone, and do lots of computing.

The answer to the boy and the 7 gallons of water is, of course, easy. The tangled financial mess into which Ikey and Mikey got themselves, becomes comparatively clear when it is found that they bought the watches for 40c each, and Mikey sold 85 with a profit of $51, and Ikey sold 15 with a profit of $9; or else they bought the watches at 50c each, and Mikey sold 92 with a profit of $46 and Ikey sold 8 with a profit of $4.

A Tennessee Teaser:

Our old friend, Jerry Kavanagh, writes in from Chattanooga to bring up a problem that is worrying some of those East Tennessee hill-billies. It's a pretty tough problem, so we'll start in with an easy one: Given the diameter of the earth as 8,000 miles, at the equator. How long would a wire have to be to pass entirely around the earth at the equator, but 6 feet from the surface at all points?

Jerry's problem is an improvement—if it can be called that. Using the same and only earth, still 8,000 miles in diameter, with a wire passing snugly around the circumference at the equator. How much would the wire have to be lengthened so that a post 6 inches high could be inserted under the wire?

Still Time for This One:

E. M. Brady, city engineer of Elkhart, Ind., says some of those we have been having are too hard (which is quite right) and sends in the following: What time is it when the minute hand passes the hour hand between 3 o'clock and 4 o'clock, provided the clock is in perfect adjustment?

One for Hot Weather:

Construct a table of logarithms with the use of only a compass and a straight edge. *Benjamin Eisner.*

We have a long and interesting letter from friend Walter S. Wheeler, which can't go in this time because of lack of space. In the meantime so long till August.

WAH

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A. PRESCOTT FOLWELL, *Editor* **W. A. HARDENBERGH,** *Asso. Editor*

Published monthly by the PUBLIC WORKS JOURNAL CORPORATION, 310 E. 45th St., New York, N. Y. J. T. MORRIS, *President;* W. A. HARDENBERGH, *Vice-Pres.;* CROXTON MORRIS, *Treasurer. Advertising representatives,* S. N. HUME, 310 East 45th St., N. Y.; FRED R. JONES, 100 No. La Salle St., Chicago, Ill.; ALONZO HAWLEY, 1635 E. 25th St., Cleveland, Ohio.

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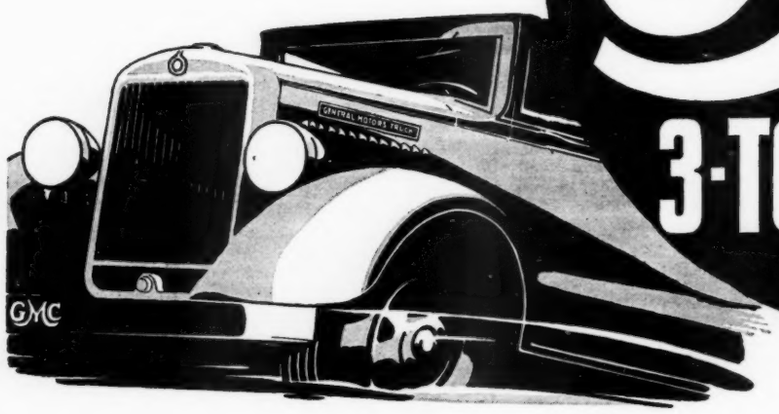

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1934

PUBLIC WORKS

City, County and State Engineering and Construction

Vol. 65 *July, 1934* No. 7

A Method of Making Pavements Non-Skid in Virginia

By J. J. Forrer, Maintenance Enginner

U. S. ROUTE 1 between Alexandria and Fredericksburg carries a high-speed daily average traffic of well over 6,000 vehicles. To take care of this heavy traffic the Virginia Department of Highways, in 1933, widened this highway to a three lane road. On the first four-mile section north of Fredericksburg the old 18-foot concrete pavement was widened on either side with concrete, and over the entire roadway sheet asphalt was laid. When opened to traffic it was found that, due to the heavy grades, the road was slick during heavy fogs and light rains. To eliminate a possible dangerous condition, a bituminous surface treatment was applied on the heaviest grades.

Materials Used

The bituminous material used for this project was the Virginia Department of Highways' specification OC-5, a cutback asphalt. It is believed, however, that the other Virginia specifications NC-5 and TC-1 for liquid bituminous materials, used with the same care, would have given results equally as good.

The cutback asphalts used in Virginia are essentially penetration asphalts, having a penetration of 85 to 100, dissolved in naphtha having an initial boiling point of 150 deg. C. (300 deg. F.) and an end point of around 360 deg. C. (680 deg. F.), in the ratio of two parts of asphalt to one part of naphtha. The Furol viscosity of the cutback at 122 deg. F. is 60 to 130 seconds.

The tar used in Virginia has an initial boiling point of about 160 deg. C. (320 deg. F.) and an Engler specific viscosity at 122 deg. F. of 25 to 45, depending on the requirements.

Slag was selected for this project on account of its dark grey color so that the treated sections of the roadway would not be unlike, in the general appearance, the untreated sections. Slag chips being cubical in shape also produce non-skid features not obtained in the flat or round aggregate. The size of the slag used was 5/8" to 3/16", not more than 10% passing the 3/16", and the Virginia Department of Highways' specifications on slag call for a weight of not less than 75 pounds per cubic foot.

Method of Treatment

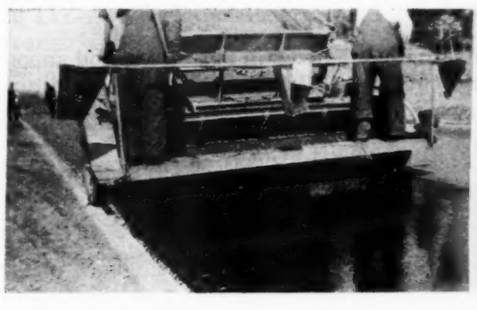
The treatment was made in March 1934, at which time the temperature ranged from approximately 40 to 50 degrees. The work was done only when the pavement was perfectly dry. All the cracks and joints were well filled with the OC-5 material, ahead of the surface treatment. Sand was spread over the cracks and joints to take up the surplus bituminous material, and then swept off, before the material firmly set up, to prevent fat spots or lines in the treatment.

The pavement was thoroughly cleaned of all foreign matter, special care being taken to get rid of dust that would adhere to the pavement. This was accomplished by a blower attached to a small tractor.

The OC-5 material was heated to 100 deg. F. and applied at the rate of .25 of a gallon to the square yard. In order that drippings from the nozzles should not smear up pavement which was not to be treated, a small trough was so attached that it automatically swung into place under the spray bars as soon as the valve was shut. The distributor was not allowed to place more material, at one time, than could be covered in 15 minutes.

The slag covering was immediately applied at the rate of 20 to 22 pounds to the square yard. In applying the slag, extreme care was taken to secure an absolutely even distribution, and no brooming of the material was allowed. Brooming, or any manipulation of the aggre-

Left—Aggregate spreader. Pneumatic-tired road wheels operate drums in bottom of hopper. Aggregate spread uniformly regardless of speed of the control quantity. Center—The aggregate before being rolled. Note even distribution. Right—Surface after four months' traffic. Note broken traffic lane lines now used in Virginia



gate after it was spread, would have prevented the securing of a uniform appearance.

Even distribution of the aggregate was obtained with a two-wheeled hopper-type spreader, with a large drum in the bottom of the hopper so arranged and driven by the road wheels that the slag was spread at a uniform rate per square yard, regardless of the speed of operation. The control gates were so arranged that the operators could not apply more than the desired amount. This spreader had been built to spread sand on icy pavements and was of the pull type, but for the purpose of covering the bituminous material on this project it was necessary to change the hitches and other attachments to the opposite side of the hopper so the trucks would back over the slag, thus preventing the wheels from picking up the bituminous material or leaving unsightly tracks.

The slag, being somewhat damp in the stock piles, was given from 15 to 30 minutes to dry, after being spread, before it was rolled. It was found that a 5-ton roller was best suited, as it did not crush the slag and still was heavy enough to cause all particles to flatten out on the pavement. Two rollings over the treatment was considered sufficient. Traffic was prevented from using the treated strip for 72 hours by placing old oil drums along the edge, with flagmen at each end of the treated section. In order to knead the slag well into the bituminous material, the trucks that were used on the project were driven slowly over the treated strip in such a way that the entire treatment was covered. This was done about 8 hours after the application of the treatment. The treatment was then given one final rolling, and blocked to further traffic until the end of the 72-hour period.

Results Obtained and Conclusions

The treatment has been subjected to traffic for four months with little or no change in appearance. During this time the temperatures have varied from freezing to 90 degrees, with considerable rainy weather. About 1% of the aggregate left the road when first opened to traffic but since then no appreciable amount has broken loose.

By the extreme care used, a surface was secured that is entirely non-skid but in no way rough or bumpy. The surface has a most pleasing and uniform appearance.

It is felt that the fact that the treated sections were closed to traffic for sufficient time to allow the volatile materials to escape, had a great deal to do with the successful results obtained.

Highway Construction for Four Years Assured

By the signing on June 18 of the Hayden- Cartwright Road act, $500,000,000 of Federal funds became available for highway work, and a continuous program for the next four years is assured. Of this amount, $200,000,000 is granted outright to the several states for immediate use; $125,000,000 is appropriated under the act of 1916, to be apportioned for the year 1936, and the same amount for 1937, under the same terms as Federal aid in the past, to be matched by other sums appropriated by the states themselves. The remaining $50,000,000 will be used for forest highways and the other Federal-built roads. The apportionment of the $200,000,000 was announced June 22, available at once.

Those interested in highways will specially appreciate Sec. 12 of this act:

SEC. 12. Since it is unfair and unjust to tax motor-vehicle transportation unless the proceeds of such taxation are applied to the construction, improvement, or maintenance of highways, after June 30, 1935, Federal aid for highway construction shall be extended only to those States that use at least the amounts now provided by law for such purposes in each State from State motor vehicle registration fees, licenses, gasoline taxes, and other special taxes on motor-vehicle owners and operators of all kinds for the construction, improvement, and maintenance of highways and administrative expenses in connection therewith, including the retirement of bonds for the payment of which such revenues have been pledged, and for no other purposes, under such regulations as the Secretary of Agriculture shall promulgate from time to time: *Provided*, That in no case shall the provisions of this section operate to deprive any State of more than one-third of the amount to which that State would be entitled under any apportionment hereafter made, for the fiscal year for which the apportionment is made.

Of the $200,000,000, at least $50,000,000 must be spent on secondary or feeder roads. Any of these funds are available for "any construction that will provide safer traffic facilities or definitely eliminate existing hazards to pedestrians or vehicular traffic."

The apportionment to the states is as follows:

State	Apportionment	State	Apportionment
Alabama	$4,259,842	Nevada	$2,302,356
Arizona	2,641,935	New Hampshire	969,462
Arkansas	3,428,049	New Jersey	3,220,879
California	7,932,206	New Mexico	2,941,700
Colorado	3,486,006	New York	11,327,921
Connecticut	1,454,868	North Carolina	4,840,941
Delaware	923,395	North Dakota	2,938,967
Florida	2,661,343	Ohio	7,865,012
Georgia	5,113,491	Oklahoma	4,685,180
Idaho	2,277,486	Oregon	3,097,814
Illinois	8,921,401	Pennsylvania	9,590,788
Indiana	5,088,963	Rhode Island	1,014,572
Iowa	5,118,361	South Carolina	2,770,954
Kansas	5,117,675	South Dakota	3,047,643
Kentucky	3,818,311	Tennessee	4,302,991
Louisiana	2,963,932	Texas	12,291,253
Maine	1,711,586	Utah	2,132,691
Maryland	1,810,058	Vermont	948,007
Massachusetts	3,350,474	Virginia	3,765,387
Michigan	6,452,568	Washington	3,106,412
Minnesota	5,425,551	West Virginia	2,280,335
Mississippi	3,540,227	Wisconsin	4,941,837
Missouri	6,173,740	Wyoming	2,287,712
Montana	3,769,734	Dist. of Col.	973,842
Nebraska	3,964,364	Hawaii	949,778

The distribution to the states is on the basis of the compromise formula prescribed by the 1933 National Recovery Act—seven-eighths according to the regular federal aid formula (which gives equal weight to the factors of population, area and road mileage), and one-eighth according to population.

Since "All sums authorized in this section and apportioned to the States shall be available for expenditure for one year after the close of the fiscal year for which said sums, respectively, are authorized" and any sums then unexpended shall be reapportioned, the work herewith provided for will undoubtedly continue for at least four years to come.

Supplementing Underground Water Flow

Los Angeles practices this to utilize storage capacity underground; Newton, Mass., and Dresden, Germany, to purify river water which is satisfactory in quantity but not in quality.

THROUGH what appears to be a coincidence, a rather unusual practice in water development as employed by three widely separated cities was described within a few weeks by three publications: The procedure at Los Angeles, described in the April *Journal* of the American Water Works Association; that at Newton, Mass., in the March *Journal* of the New England Water Works Association; and at Dresden, Germany, in the May 3 issue of *Engineering News-Record*. It is interesting to note the similarities and differences between these three.

Spreading, or artificial replenishment of underground basins, was used at one place in California about 1896, but only during the past ten years has it been adopted by a number of water works. In Southern California, where reservoir sites are few in number and exceedingly expensive per acre foot of storage, spreading is employed for providing underground storage to smooth out seasonal fluctuations. Los Angeles in this way stores peak flows of Owens River Valley water in San Fernando Valley, recovering it from the latter valley by two lines of wells extending across the valley, one line at the lower end, the other at about its mid-length.

Newton, Mass., began in 1928 the increasing of its supply (which is obtained from wells) by pumping water from Charles river into a basin in the gravel hills situated above and between the two wells; the river water was not used directly because of its pollution. This was increased in 1929 and again in 1930.

Dresden obtains its water supply from wells driven along the bank of the Elbe river, most of it reaching the wells from the river. The water is high in manganese. To increase the supply and purify it, water is pumped from the river to concrete-lined settling basins, thence through rapid sand filters, then through aerators (to remove tastes and odors) into nine basins with 8 in. sand bottoms, through which it seeps into the ground. Tubular wells (about 120 in number) surround these basins about 200 feet from them and withdraw both this water and that coming directly from the river through the natural soil.

Los Angeles Investigations

The best procedure for both spreading and recovering water will vary with local conditions—physical, cost of land, times and rates when recovering will be necessary are some of them. Los Angeles selected use of basins especially constructed and systematically cleaned and operated. Test basins were observed for two years, and these studies continued in the operation of the 47 acres now in service. Some of the results of these studies are as follows:

Rates of percolation varied from 3.0 to 10.0 acre-feet per acre per day on the net area exposed; for the gross area, including spoil banks and roads, a mean of 1.0 cu. ft. per sec (2 acre-feet per day) per acre was considered a safe basis for estimate for operation of a major spreading grounds.

The water table was 100 ft. below the ground surface, and it was five days after flooding before the table began to rise—a percolating rate of 20 ft. per day.

Velocity of flow through the soil, as indicated by the length of time required for wells to reach their maximum elevation from the time spreading started, was 3.0 to 4.4 miles per year with an average slope of 2.61 ft. per 1,000 ft.

In operation, the water on the beds is maintained at a depth of about 6 inches, which prevents wave action cutting into the banks of the basin. If a basin is allowed to drain out, if only for an hour, the rate of percolation decreases, proving continuous operation gives higher rates of percolation than does intermittent.

Of several factors entering into the unit rate of percolation—wind, rain, lack of cultivation, etc.—water temperature is apparently one of the most important. The average monthly rate of percolation in 1932-1933 varied from a maximum of 11.22 feet in July to a minimum of 5.46 feet in February, the monthly rise and fall closely following that of the water temperature.

During the 1932-1933 season the water table stood 21 feet higher than when water spreading started.

In addition to using these basins, the water department also places annually several thousand acre feet of water in gravel pits located in the upper portion of the valley, further from the supply wells. If, in the fall, the indications are for a wet season, most of the spreading is concentrated in these pits, thus delaying the arrival of the water at the service wells. If, however, little spreading water is available until late spring, all spreading is concentrated on the basins and a few pits near the point of diversion.

The surface of the basin soil becomes clogged with use, and is loosened by cultivating with a spring-tooth harrow after it has been allowed to dry to the point where it does not either form a muck or break into clods.

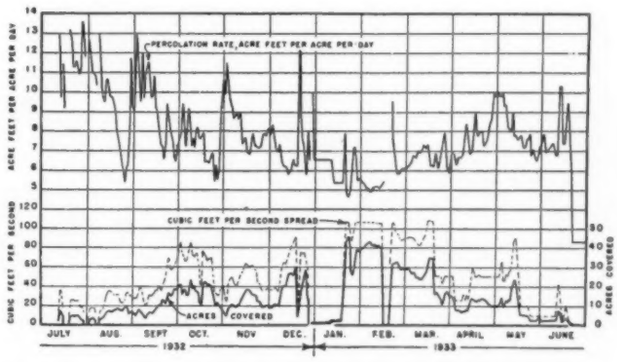


Diagram Showing Area Covered, Quantity Spread and Rate of Percolation at Tujunga Spreading Grounds, 1932-33

This forms ridges and furrows 0.2 to 0.3 foot high, into the latter of which the silt settles, leaving the crest free for percolation. After two years' service there is no sign of permanent sealing of the soil; in fact, both at the surface and lower down it contains less fine material than when spreading started.

The cost of preparing these basins was $1269 per acre of gross area, consisting of $423 for land purchase, $506 for pipe lines and valves, and $340 for basin and road construction. The cost of spreading during the 1932-1933 season, per acre-foot of water, was 16 cts for capital investment, 12 cts for land investment, and 38 cents for operation and maintenance charges. In contrast, the average annual charges per acre-foot of storage on four surface reservoirs in the San Fernando Valley is $5.70 for capital investment and $3.23 for operation and maintenance. The capacity of this storage basin is 150,000 acre-feet, more than twice the capacity of the city's largest surface reservoir.

"In the future, the most important contribution to the water supply of semi-arid areas will be the intensive development and use of groundwater storage basins by means of water spreading," said D. A. Lane, who was the author of this paper.

At Newton, Mass.

Newton began the actual use of this method in 1928, pumping from the river to increase the pumpage from wells one-quarter mile distant. In 17 days after pumping began on an area of 0.64 acre the two wells affected increased in yield from 1,960,000 gpd to 2,830,000; the 870,000 gpd being 62% of the water pumped. The quality of the water was investigated, that of the river being considered too polluted for use, and "in general it was found that a lateral distance of 150 feet from the flooding basin to the point of collection was more than ample, in the rather coarse gravel strata, for the complete purification of the river water. This distance was established as a minimum in the design of subsequent flooding basins."

Later two more areas were stripped of top soil down to the gravel and flooded. At present the city is pumping about 2,500,000 gpd on to the flooded areas and recovering 1,370,000 gpd more than before this flooding was begun.

It will be noted that, while the chief aim of Los Angeles was the storing of water underground as a substitute for more expensive or unavailable reservoir storage, that of Newton was purification of a supply which was continuously ample but of unsatisfactory quality.

The water recovered by Newton through wells is pumped into a wooden conduit which acts also as an infiltration gallery. In 1930 flooding of other areas along the conduit was begun, and for about a year past two basins and a gravel pit (see map) have been flooded, about three-fourths of the flooding water finding its way into the conduit by gravity. The city now believes that it can obtain from both natural ground flow and flooding at least 8,000,000 gpd. of which more than 50% is from the latter. This 8,000,000 is the maximum amount which the city is permitted, by legislative regulation, to withdraw from "the Charles river and the adjoining water works reservation."

This latest development was made with the advice of Weston & Sampson as consulting engineers, the paper describing it having been read by George A. Sampson early this year before the New England Water Works Association.

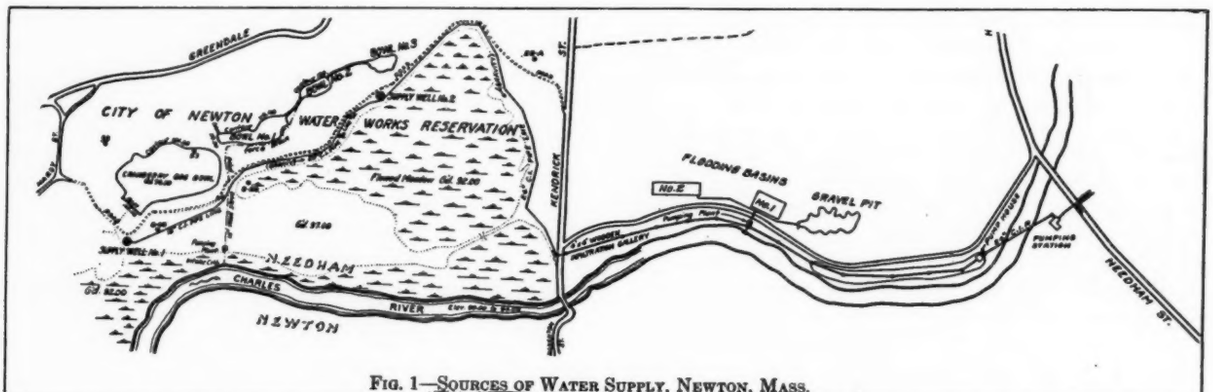


FIG. 1—SOURCES OF WATER SUPPLY, NEWTON, MASS.

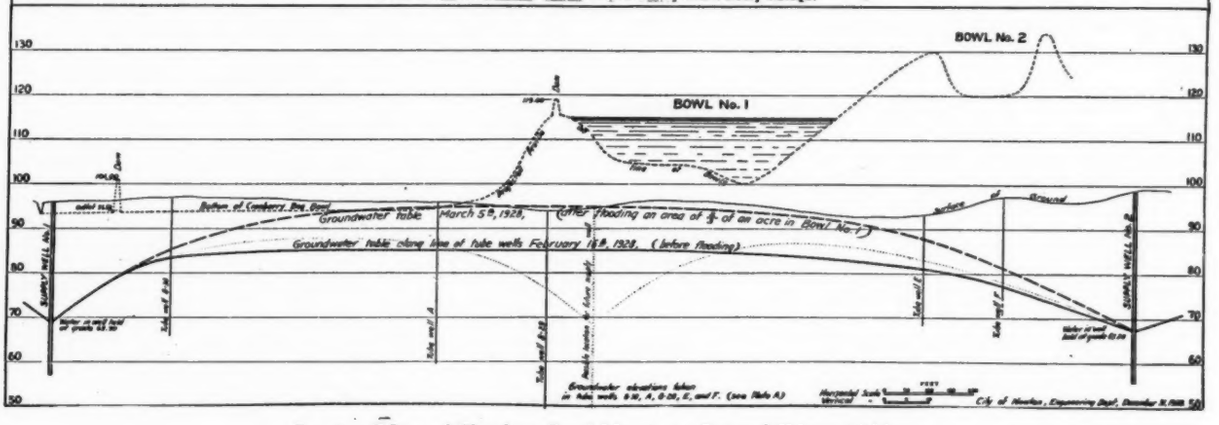


FIG. 2—*Effect of Flooding Bowl No. 1 on Ground Water Table.*

Drying and Incineration of Sewage Sludge

By Willem Rudolfs[2] and Wm. H. Baumgartner[2]

Several comments on Mr. Stilson's article which appeared in the May and June issues of Public Works have been received. One of them is given herewith, and others will appear in the August issue.

MR. STILSON has kindly sent us an advanced galley proof of his paper with the above title to be published in PUBLIC WORKS. His treatment of the subject—or rather part of the general subject indicated in the title—is worth study by those interested.

Although fine screenings are "big brothers" of the smaller particles called "fresh solids," the character is somewhat different on account of the segregation processes taking place on screens, settling and aeration tanks. As a rule the moisture content of screenings is lower than of fresh solids, the nitrogen content is lower and although the total carbon content is higher of the screenings, the type of carbon compounds is different. The amounts of fatty substances (greases) are higher in fresh solids, whereas the carbohydrate content in general is higher in screenings.

Again, we have an entirely different material when dealing with digested sludge. The digestion process destroys from 40 to 70% of the original organic matter present, leaving mostly fibrous material of a hemi-cellulosic nature as a residue in addition to the original ash.

Garbage and screenings are more comparable than fresh sewage sludge and screenings. Screenings and garbage have a somewhat higher moisture content than sludge cakes obtained from filtering devices with or without chemical pre-treatment. Fresh solids obtained from primary sedimentation tanks, activated sludge or sludge obtained from humus tanks is more gelatinous than either screenings or garbage, while digested sludge may not be more gelatinous but is far more finely divided. These characteristics play a role in the production of filter cake. Biological decomposition and stabilization, whether anaerobic or aerobic, is common to garbage, screenings or fresh sludges, but the rate of decomposition and the biological changes taking place are different. Sewage sludges, because of their gelatinous structures and finely divided state seem more amenable to partial biological decomposition.

Keeping in mind the differences and several factors which are involved, it is readily understandable why mechanisms used in other industries for apparently similar purposes and adapted to sewage treatment have often but moderate success, unless considerably modified. These modifications are often made after a number of trials or after considerable experimentation. There is no doubt in our minds but that in order to make sludge incineration a success experimentation and study is required. This holds for the three steps set forth in Mr. Stilson's paper, namely: (1) dewatering to a concentrated cake, (2) drying to prepare the sludge for firing, and (3) complete combustion.

To date, the first step, dewatering of the sludge by filtration, has by no means been made as economical and efficient as possible. Some measure of success has been attained on filtration of digested sludge, although the process is still expensive. The same holds for activated sludge and mixtures of fresh solids and activated sludge.

Although the problem of dewatering fresh solids alone has been hardly touched, work in our laboratory shows them to be somewhat more amenable to filtration with lower costs for conditioning than the sludges heretofore mentioned. Since the combustible content of fresh solids is roughly twice that of digested sludge the incineration of fresh solids cake is more attractive for burning in regard to heat requirements.

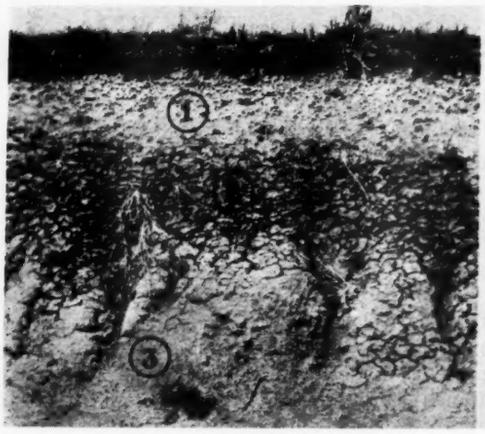
As soon as dewatering of fresh solids is practiced, incineration of the resulting cake must necessarily be resorted to, because of odor and other nuisances, and because dewatered fresh solids cakes would not be very popular as fertilizer even if the different State Health Agencies had no objection. A survey made sometime ago about the possibilities of using dewatered and dried fresh solids as a fertilizer or fertilizer base did not look promising from the standpoint of probable market conditions and the rather peculiar odor of such dried material, which increases with time of storage. When an efficient and economical method of dewatering has been determined it becomes therefore almost mandatory to incinerate the fresh solids. On the other hand digested sludge cake can be disposed of by using it as fill or spreading on the ground without undue nuisances.

Sludge conditioners used so far for fresh solids dewatering have been applied in the acid and/or alkaline range. When such treated material is dried in preparation for firing we have different odors, produced, depending upon the manner of treatment. Sludge cake produced under acid conditions give off on drying, the acrid odor of the higher organic acids, such as butyric, etc. Sludge produced in the alkaline range have an amine and ammonia odor on drying. With the present state of our knowledge it is questionable whether neutralization of the acid odors in the sludge cake would be feasible by the use of lime.

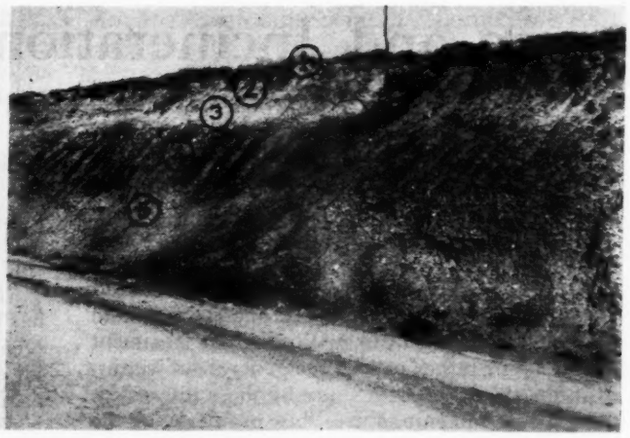
Although bacterial activity is retarded at a temperature of 125° F when mesophillic digested sludge is dried, bacterial activity and odors emanating from fresh solids at this temperature are appreciable. To retard greatly bacterial activity the temperature must be raised to about 170° F. We have found that fresh solids heated to 125° F still give off considerable quantities of volatile substances, but materially less and at a much slower rate than at higher temperatures. Bacterial decomposition of the cake, with its attendant odor production, should not be, as a rule, a problem after dewatering. The problem is more related to the original material and is often linked up with sulfates present. One of the greatest sources of hydrogen sulfide are the sulfates present in solution in the water. When sulfates are practically absent or present in small quantities, it takes some time (usually several days, before the hydrogen sulfide is formed from organic material. Ordinarily the quantities of water-soluble sulfates in the sludge cake are rela-

(*Continued on page 30*)

[1]Journal Series paper N. J. Agricultural Experiment Station, New Brunswick, N. J., Dept. Water & Sewage Research.
[2]Chief, Dept. Water & Sewage Research.
[3]Research Asst., Dept. Water & Sewage Research.



Profiles of Iredell silt loam showing (1) lighter textured upper soil layer, (2) heavy, plastic sticky, wavy clay, and (3) decomposed rock



Profiles of Leonardtown silt loam showing (1) grayish brown granular silt loam, (2) brown, granular silty clay loam, (3) gray, compact, sandy hardpan, (4) pliable clay, and (5) compact clay.

Description of Soils Used in Highway Construction*

By the Division of Tests, U. S. Bureau of Public Roads
Reported by C. A. Hogentogler, Senior Highway Engineer

ALL soil is derived from the bed rock, which forms the outer shell of the earth, by gradual weathering and the disintegrating action of air, moisture, heat, cold, frost, and chemical agencies. Soils that exist where they were formed are said to be *in situ;* those that have been carried from their place of origin by glaciers, wind, or water are called "transported soils."

Glacial deposits generally lack uniformity of formation and properties. Soils *in situ,* and those transported by wind, such as the loess, and by lakes and rivers, such as silts, clays, and mucks, occur in the earth's crust in series of layers forming what is known as the "soil profile." The several layers differ in their characteristics but, within themselves, are uniformly weathered.

Soils of a profile graded by mechanical analysis, are designated as "sands," "clays," "loams," "silt loams," etc. Sandy materials are described as "light-textured and clays as "heavy-textured" soils. The chart, below. developed by A. C. Rose of the U. S. Bureau of Public Roads, shows the mechanical grading of the various designations of texture.

Profiles developed under the same geological environment belong to the same soil series. The different series are designated by such names as "Chesterfield," "Putnam," "Berks," "Susquehanna," etc.

In well-drained soils of the humid regions the profile

*Second of a series of articles on the utilization of soil analysis in economic highway construction.

Subgrade soils are also classified as to texture as follows:

Soils Containing Less Than 20% of Clay

Coarse Sand—More than 25% of fine gravel and coarse sand, and less than 50% of any other grade.

Sand—More than 25% of fine gravel, coarse and medium sand, and less than 50% of fine sand.

Fine Sand—More than 25% of fine sand or less than 25% of fine gravel, coarse and medium sand.

Very Fine Sand—More than 50% of very fine sand.

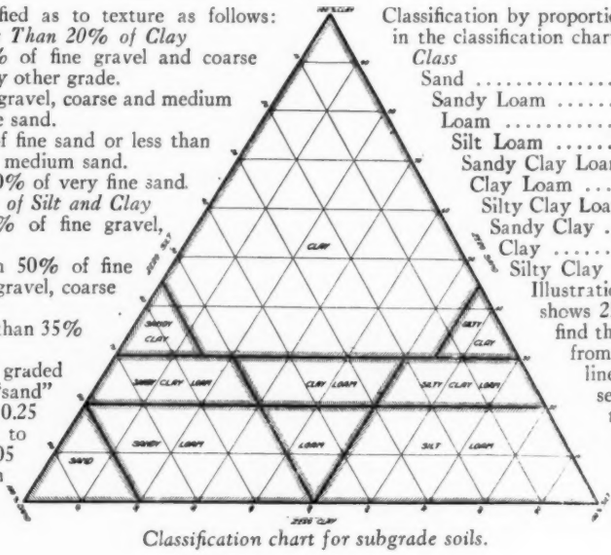
Soils Containing 20 to 50% of Silt and Clay

Sandy Loam—More than 25% of fine gravel, coarse and medium sand.

Fine Sandy Loam—More than 50% of fine sand or less than 25% of fine gravel, coarse and medium sand.

Very Fine Sandy Loam—More than 35% of very fine sand.

By the size of particles, sand is graded "coarse" if 1.0 to 0.5 mm.; "sand" if 0.5 to 0.25 mm.; "fine" if 0.25 to 0.1 mm.; "very fine" if 0.1 to 0.05 mm. Silt is 0.05 to 0.005 mm,, and clay is smaller than 0.005 mm. These gradings by size are used in making the above classifications.



Classification chart for subgrade soils.

Classification by proportions of sand, silt and clay, as shown in the classification chart:

Class	*% Sand*	*% Silt*	*% Clay*
Sand	80—100	0— 20	0— 20
Sandy Loam	50— 80	0— 50	0— 20
Loam	30— 50	30— 50	0— 20
Silt Loam	0— 50	50—100	0— 20
Sandy Clay Loam	50— 80	0— 30	20— 30
Clay Loam	20— 50	20— 50	20— 30
Silty Clay Loam	0— 30	50— 80	20— 30
Sandy Clay	55— 70	0— 15	30— 45
Clay	0— 55	0— 55	30—100
Silty Clay	0— 15	55— 70	30— 45

Illustration of use of chart: If analysis of soil shows 25% clay, 60% sand and 15% silt, find the 25% clay (middle of second strip from bottom) and the 60% sand (sixth line from the right side). Their intersection is near the center of the section labelled "sandy loam," showing that the soil is a typical sandy loam. If the clay constitutes more than 30% of the soil, and more than 15% of either silt or sand, it is classed as clay and has its typical qualities.

consists of a light-textured upper layer designated by the agronomist as the "A" horizon underlaid by a heavier-textured layer known as the "B" horizon. A still lower third layer of unweathered or incompletely weathered geological formation is known as the "C" horizon or parent material. Each horizon or layer may be subdivided, as A_1, A_2, B_1, B_2, etc. For engineering purposes, the various layers may be numbered consecutively from the top down as shown in figure 3, without reference to horizon.

Part of Profile Affected by Seasonal Change

During rains and thaws, moisture enters the soil by gravity and forms the ground water which seeps through permeable soil strata to feed wells and springs. Surface tension causes some of the precipitated moisture to penetrate the soil independent of gravity and maintain a moistened soil layer above the ground water elevation, termed the "capillary fringe."[2] During dry weather, moisture rising from the water table through the capillary fringe evaporates continuously from the surface of the ground unless prevented by an impervious covering, in which case the soil immediately beneath the covering may become saturated. Capillary moisture is necessary to the growth of plants but it is also responsible for many serious road troubles.

Soils expand during the penetration of moisture and shrink when evaporation occurs. During frost, both ground water and capillary moisture segregate to

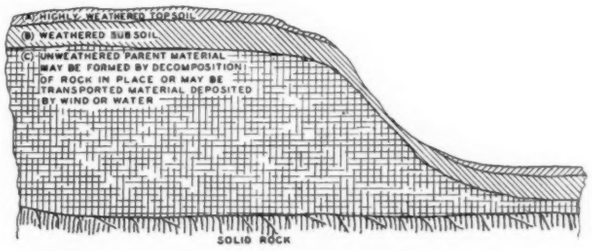

(A) HIGHLY WEATHERED TOPSOIL
(B) WEATHERED SUBSOIL
(C) UNWEATHERED PARENT MATERIAL MAY BE FORMED BY DECOMPOSITION OF ROCK IN PLACE OR MAY BE TRANSPORTED MATERIAL DEPOSITED BY WIND OR WATER
SOLID ROCK

Fig. 3—Typical profile showing "A," "B' and "C" horizons

cause heaving and during subsequent thaws they cause the soil to lose stability. Thus, to the depth of moisture and frost penetration the soil is continually changing in moisture content, and related properties, with variations in weather conditions.

Tests of several hundred soil samples during a three-year period by F. H. Eno[3] show that the moisture content of the upper 24 inches of the campus soil at the Ohio State University varies from a minimum of 8.7 percent to a maximum of 37.8 percent of the dry weight of the soil. "Rain, snow, freezing, thawing, wind, sun, and cloud change the top inch or two inches very quickly from about 2 percent up to 124 percent of the dry weight of the soil," the test report states.

Thus, in addition to variations due to difference of materials forming the layers of the profile, the properties of the soil may change radically with seasonal alteration of the layers near the surface caused by climatic changes.

Properties Change When Natural Structure of Soil Is Disturbed

Further to complicate the matter, the same soil material, under identical climatic conditions, may undergo a radical change in character when removed from its natural place in the soil profile, or when it is broken up, consolidated or otherwise disturbed in its preparation

Fig. 5—Photomicrograph of loess soil, showing remnants of tubes responsible for high vertical cleavage.

for use. The arrangement soil particles developed during the ages by varying pressure, and other natural constructive and destructive elements, can seldom be reproduced in a short time by artificial means. Disturbance of the natural structure, therefore, often results in changes in the properties of soil resulting from its structure. Thus, in the natural state, the soil may be more porous, have higher permeability, and be more stable than the same material in the disturbed state.

F. H. Eno found, from the tests mentioned, that the porosities of soil in natural state were considerably higher under similar conditions of wetting and drying than those of samples of the same soil in disturbed state; and it is a well-known fact that with careful tamping the backfilling of a trench will require more than the excavated soil.

Fig. 4—Vertical face of cut through loess deposit in Mississippi.

Terzaghi[4] found the permeability of a sample of clay from Spanish Honduras to be 75,000 times greater in the natural than in the disturbed state.

Casagrande[5] reports, among other examples, the bearing value of a confined clay sample in undisturbed state as 10 tons per square foot as compared with slightly less than 2 tons per square foot for the same sample at the same density when remolded. The porosity of the undisturbed sample was 54 percent; that of the disturbed sample capable of sustaining the same load was 45 percent. In other words, to sustain the same load, greater density was needed in the disturbed than in the undisturbed soil.

The performance of loess furnishes a spectacular illustration of the effect of natural structure. In the natural state this soil is so resistant to erosion and so stable as to maintain indefinitely almost vertical faces in cuts. (See fig. 4). When removed from the profile and manipulated for use as in a subgrade, it loses stability readily in the presence of moisture and becomes exceedingly troublesome, especially when the frost is leaving the ground.

According to Pirrson and Schuchert in their Textbook of Geology[6] the stems and roots of successive generations of grasses growing on the loess deposits (formed from dust clouds carried by the wind) and buried by the rising accumulations, have by their decay produced the slender vertical tubes responsible for the high vertical cleavage of loess. (See fig. 5).

Properties of Disturbed Materials Change With Method of Preparation

Finally, the same soil material in the disturbed state under identical climatic and topographic conditions may perform differently depending upon the moisture content at the time of consolidation and the manner in which the consolidation is acomplished.

During the Bates Road tests, subgrade soil more or less dry when covered with the pavement became wetter subsequently than similar soil in a damp or moist condition when the concrete was placed.[7]

In the soils laboratory of the U. S. Bureau of Public Roads, compressed samples of silt and clay soils, which resisted slaking indefinitely if saturated, distintegrated quickly if dry when immersed in water.[8]

Recently R. R. Proctor[9] has shown that earth dams and similar embankments may serve satisfactorily or otherwise, depending on the moisture content and the degree of compaction employed during construction.

Thus, the properties of soil differ (a) with differences in the materials comprising the individual layers of the profile and (b) in the same soil material, when located in the profile below or above the line of seasonal change, when removal from the profile destroys the natural structure, and finally when prepared for use by different methods of construction.

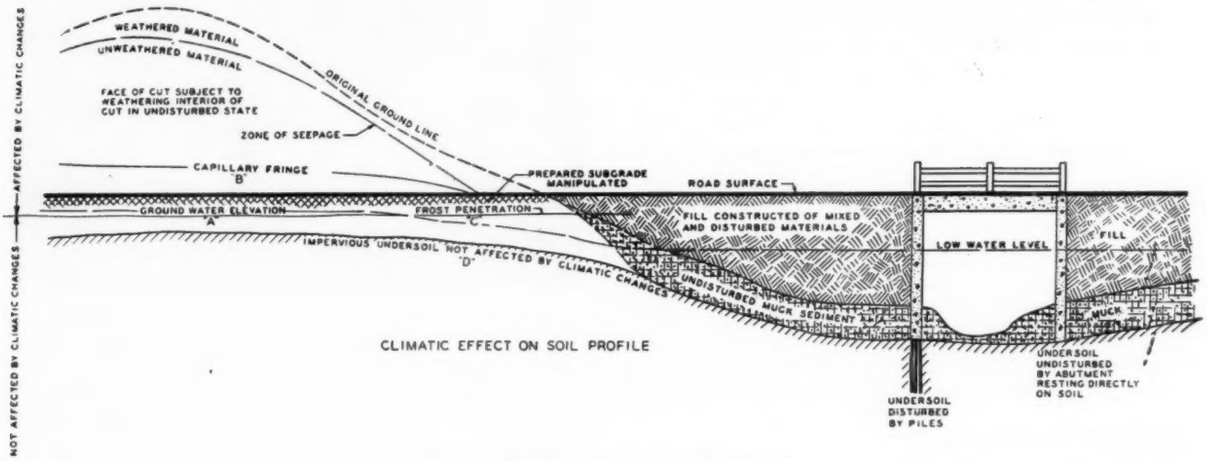


Fig. 6—Climatic Effect on Soil Profile

Highway Construction Requires Knowledge of Soil in All States and Conditions

Soil analysis for highway purposes must disclose the properties of soils in all states. Figure 6 illustrates how highway construction utilizes soil in natural state, in disturbed state, and located both above and below the line of seasonal change. To the left of the figure is a cut through the natural profile with soil faces in the undisturbed state which must withstand the erosive action of precipitation, frost, and alternate wetting and drying. Here the road rests on a thin layer of manipulated soil, supported by undisturbed undersoil, within the range of capillary moisture and seasonal change. To the right the pavement is supported by a high fill of disturbed material resting on a soft sediment of questionable bearing value. Both bridge abutments extend below the line of seasonable change, the soil under the right abutment being undisturbed and that under the left abutment being partially disturbed by pile driving.

2. Meinzer, O. E. The occurrence of ground water in the United States. U. S. Geol. Survey, Water Supply Paper 489, 1928.

3. Highway subsoil investigation in Ohio. Bull. No. 39, The Engineering Experiment Station, The Ohio State University, 1928.

4. Interrelationship of load, road and subgrade, Public Roads, vol. 10, No. 3, May, 1929.

5. The structure of clay and its importance in foundation engineering, Boston Society of Engineers, Vol. 19, No. 4, April, 1932, fig. 10.

6. John Wiley and Sons, 1920.

7. Highway research in Illinois, Trans. A.S.C.E., 1924.

8. Subgrade soil constants, their significance and their application in practice. Public Roads, vol. 12, No. 4, June. 1931.

9. Fundamental principles of soil compaction. Engineering News-Record, Aug. 31, Sept. 7, Sept. 21, and Sept. 28, 1933.

THE EDITOR'S PAGE

"Limited Ways" for Highway Safety

Physical separation of traffic streams moving in opposite directions, elimination of all intersections and of connections with abutting property, and specially constructed entrances and exits are advocated by Dr. Miller McCilntock, director of the Erskine Bureau for Street Traffic Research, Harvard University. Such a limited way can be constructed in the heart of any city, affording not only a fool-proof right of way for automobile operation, but also converting present-day slow and congested traffic streams into economical high-speed movements. Safe speeds up to fifty miles an hour to the very centers of congested areas are reasonably anticipated.

Such a limited way can be constructed by elevating the main route, by depressing it, or by providing a special treatment of an existing surface route. The first method has been selected for the 160-mile system designed for the city of Chicago. It is estimated that by careful design the cost of such work may be actually less than the cost of widening existing streets.

A study of the nine hundred traffic fatalities which occurred in Chicago during 1933 shows that only 17 of these deaths occurred under conditions which would have been possible if all traffic had been moving on limited ways. The two largest causes of deaths involved pedestrians and collisions at intersections. On a limited way there are no pedestrians and no intersections; in fact, about the only type of accident possible is rear-end collision.

Experience has shown that neither education nor punishment will solve the problem, and that the highway itself must be built to eliminate accidents. The step suggested by Dr. McClintock is in the right direction, and holds out a great deal of promise.

Sanitary Engineering Sustains a Great Loss

In the recent death of George W. Fuller the sanitary engineering profession loses its most prominent member, in which position he succeeded his former partner, Rudolph Hering. His decisions were always based on sound technical foundation, but he was not afraid to support and promote new ideas; perhaps the most striking illustration of the latter being his prominent part in the development of rapid sand filtration for the purification of potable water supplies, and his advocating of it against the opposition of many sanitary authorities. (It was many years before the Massachusetts State Board of Health would endorse this process for use by Massachusetts municipalities.)

He observed conscientiously the ethics of the profession, and was generous with his time and talents in promoting its best interests. Much of the work which he did as chairman of committees of the American Water Works Association and the American Public Health Association will survive for many years to benefit his fellow members of the profession, notably in the "Standard Methods of Analysis for Water and Sewage" and the "Manual of Water Works Practice."

Quick Work by P. W. A.

As we go to press, July 2, we learn that up to and including Sunday, July 1, 1,241 non-Federal allotments had been made from the new $500,000,000 appropriation (which had been available only a week) calling for an outlay of nearly $190,000,000 from this fund.

Of last year's $400,000,000 highway appropriation, $66,000,000 of work has been completed, $266,190,000 is under construction, $18,258,000 of projects have been awarded, and $15,440,000 have been approved but not awarded, leaving 7% of the fund for which work has not yet been approved, a year after the apportionment.

The difference is explained largely by the fact that all—PWA officials and personnel, and state, county and town officials—know better how to get together, and because both had plans all ready to take immediate advantage of the expected appropriations.

Round Table Discussions

Most societies which contain in their membership considerable numbers of men who have charge of the operation of water works, sewers and other public works, assign a period at each convention for a "superintendents' meeting" or "round table discussion," with the idea especially in mind of getting superintendents from the smaller cities to exchange experiences they have had in solving the problems that they have in common. And in most cases the result is the same—the small-town superintendents will not use the opportunity, and the time is occupied by the big-city boys and consulting engineers.

We would like to suggest a procedure that it seems to us might work. Let the Secretary, two months before the convention, send a letter to all small-plant superintendents asking them to submit questions which they would like to have discussed. Then let him, a month later, send a list of those questions to the same men asking them to come prepared to discuss such of them as they can; or, if they cannot attend, write out (the more briefly the better) what they have to tell. Then, when they meet at the convention, exclude everybody else. Perhaps, if Wm. W. Brush of New York isn't there (and we know of no man who has a broader fund of information to draw on for the edification of every class and size of water works men, but he sure is no *small-town* superintendent) or other superintendent or consultant of outstanding ability, after a few moments of silence some braver spirit will break the ice; and after that we believe the difficulty will be to adjourn the meeting in time for the next session.

Build Now for Low Maintenance

In planning the work which PWA is urging cities, counties and states to perform, it is important to bear in mind future maintenance costs. Money for initial construction apparently will come easily, but maintenance will be a continuing charge on the local community. The best of engineering design, construction materials, and equipment to insure proper construction, will be real economy for the future.

A Year's Developments in Sewage Treatment

Trickling Filters—Activated Sludge—Imhoff Tanks—Sludge Digestion Sludge Disposal.

CHEMISTS and biologists continue to be active in the study of sewage treatment, the latter in spite of the diminishing dependence being placed on biological methods; and engineers, mechanical as well as sanitary, are employing their ingenuity in devising new methods. But during the past year all of these have devoted their energies chiefly to perfecting their knowledge of the principles involved in methods already in use and details of carrying out such methods. "The study of organic and inorganic colloidal substances present in sewage, their behavior and changes with different methods of treatment, is very much in its infancy" says the Committee on Research of the Federation of Sewage Works Associations, in a recent review of the literature of 1933 dealing with this subject.*

This excellent report presents very fully and completely the recent progress in the science of sewage treatment. Some of the more important features are abstracted briefly in the following paragraphs. These are chiefly conclusions by individual investigators, which may or may not have received general acceptance.

Trickling Filters. Bach and Blunk believe that 0.4% CO_2 in the air in filters is toxic, and its presence in most filters retards nitrification; and the latter recommends that the CO_2 be swept out by applying air artificially. He finds the time of passage of sewage through filters is 1 to 5 hours instead of a few minutes and believes continuous operation better than intermittent. (Forced aeration and continuous operation have been tried and abandoned several times during the past 40 years. Ed.)

When applied to filters, "Gas house waste containing relatively high concentrations of phenol was detrimental to all other sewage bacteria (except one isolated Gram negative vibrio) so that biological stabilization was ineffective."

At Allentown, Pa., heavy chlorination of the filters every ten days effectively controls fly breeding.

Activated Sludge. "The activated sludge process remains the tried and approved method for producing the highest quality effluent.

"The coating of slime adhering to the walls (of an activated sludge tank) was investigated (in Germany) and found to be very important. By decreased aeration the load on the tank could be doubled when a good growth of slime was present."

Bulking can be predicted by "increase in volatile content of suspended solids, increase in dissolved oxygen, rapid increase in B.O.D. and increase in filamentous character of the sludge." Dairy waste began to bulk when aerated for 5.5 hrs. Ferric chloride will control bulking.

Iron does not interfere with clarification, but more than 100 ppm. definitely decreases nitrification.

Successful operation requires: (1) Intimate mixing of the sludge and sewage during the aeration period. (2) The preservation of aerobic conditions in the plant. (3) Storage capacity in the plant to deal with peak loads. (4) Systematic discharge of surplus sludge under controlled conditions.

Perhaps more effort has been directed to reducing operating costs than to any other line of endeavor. At Collingswood, N. J., a substantial saving was made in operating cost by alternately aerating for 10 minutes and resting for 5 minutes, throughout the 24 hours, using clock control. At Lima, O., activation is discontinued in winter, when sedimentation and dilution are relied on.

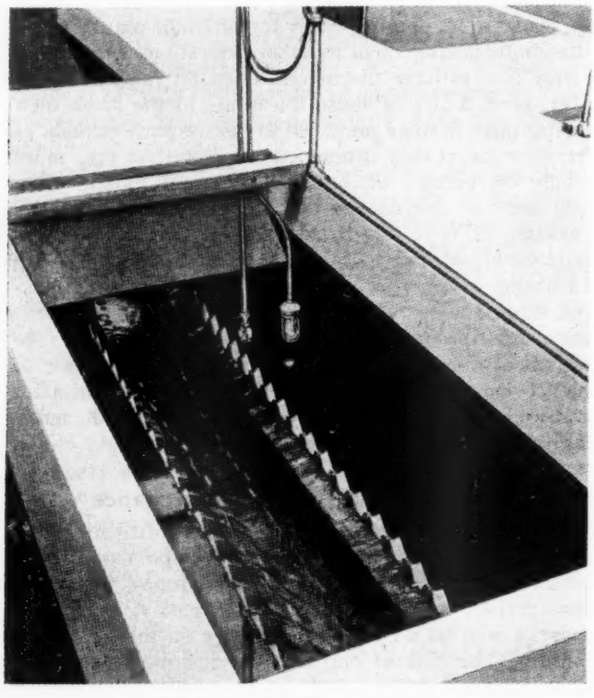
Pre-aeration is being used with quite a number of activated sludge plants. Applied ahead of primary settling tanks, sedimentation is improved, grease is liberated and odors are blown out. The design of pre-aeration devices is not definitely standardized, the time of aeration varies from 10 to 30 minutes and the amount of air from 0.05 to 0.10 cu. ft. per gallon.

Sludge blanket depth detectors are used in several plants. At Morristown, N. J., a photoelectric cell causes the automatic opening and closing of valves which regulate the sludge level.

By prechlorination, the Los Angeles County Sanitation Dist. increases the efficiency and capacity of its activated sludge plant because the sewage reaches it in a fresher condition.

Imhoff Tanks. At Dayton, O., Imhoff tank performance has been materially improved by prechlorination, showing an average increase in B.O.D. reduction of 16%, and other advantages, such as scum reduction in the vents and less suspended solids in the influents.

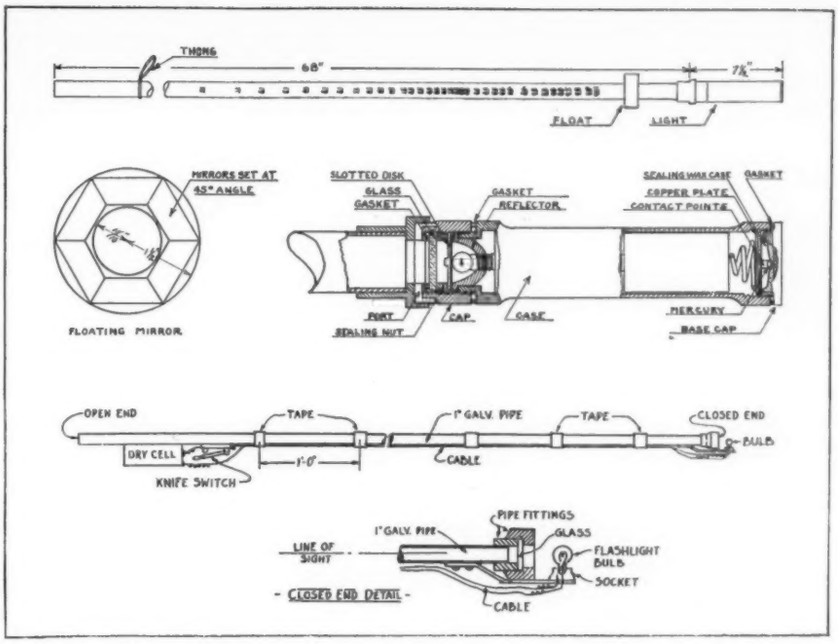
*Sewage Works Journal for March, 1934.



Photronic cell and light source used for regulating sludge height at Morristown, raised above surface of settling tank.

This also effects odor control at Cleveland's Southerly plant.

Sludge Digestion. Sludge kept at 37° C. digests slightly more rapidly than at 28°, but ultimate digestion time does not vary materially between 28° C. and 42°. Heisig found that gas production at 130° F. was considerably higher than 85°, and that daily charges to the former could be 70% greater than to the latter with equally good results. At Peoria, 40% of the volatile matter was found to digest at 90° C. in ten days and the remainder of the digestible material at a lower rate at lower temperatures. Heating tanks at Baltimore by circulation of hot water through coils as compared with direct addition of it to the sludge showed that the former required less heat and produced 24% more gas, and the sludge withdrawn contained 15% less solids.



Top—Portable turbidimeter and sludge blanket detector used at Indianapolis sewage treatment works. Bottom—Sludge blanket detector used at Tenafly, N. J.

Springfield, Ill., in 1933-34 obtained a net saving of $4,130 by using sludge gas for operating its engine plant, allowing 10% for fixed charges. The engine produced an average of 65% of the power needed for aeration—94.3% in January, 1934—the average air consumption being 1.02 cu. ft. per gallon. Gas produced, 0.6 cu. ft. per capita per day.

It has been established that prechlorination improves sludge digestion rather than the converse.

Sludge Disposal. The use of vacuum filters for dewatering excess activated sludge has become well standardized, using ferric chloride as the principal coagulating agent. Filter rates, 1 to 5 lb. per sq. ft. per hour. At Hagerstown mixed activated and fresh solids were filtered by Wright vacuum filters, using lime and paper pulp as conditioning agents; but recently ferric chloride and lime have been used instead, with greatly increased filter yield and more dependable operation. At Baltimore, washing the digested sludge prior to filtration has resulted in very much higher yields and a striking economy in chemical requirements; the theory being that ammonia compounds are responsible for the difficulties of conditioning sludge and can be removed by simple elutriation.

In a Chicago experimental plant, activated sludge with a small amount of settled solids was filtered on an Oliver filter, the filter cake dried in a rotary drier, and the dried sludge burned in the fire-box of the dryer, thus treating 20 tons a day of sludge on the dry basis. Recently, as an improvement, the filter cake is passed through three Raymond hammer mills, together with hot gases from its incineration, and the moisture reduced to 40%, and then to 15% in a fourth mill, and blown into a pulverized fuel furnace; all gases and evaporated moisture being deodorized in the high temperature zone of the furnace. It is believed no additional fuel will be needed.

The new Plainfield, N. J., plant includes a vertical steel tank for thickening the sludge by flotation after dosing with alum, and a spray dryer as furnished by Industrial Associates, Inc. to dewater the thickened sludge from a moisture content of some 88% down to 20%. The dried sludge will be either incinerated immediately or sold as powdered fertilizer material.

Centrifuges are still being tried out in both England and America, but none has yet proved satisfactory for dewatering either sludge or sewage.

Miscellaneous. No results of laboratory research in *chemical precipitation* were published last year. There is a "dearth of fundamental research dealing with questions such as the reactions involved, effect of interfering substances, effects of dispersion, flocculation and coagulation of the colloidal and soluble materials. The need for more effective preciptants than those utilized at present is apparent."

For precipitation of trade wastes, practically every type requires a different specific chemical or mixture of chemicals for satisfactory coagulation.

In *chlorine* disinfection of sewage, the rate of B. coli kill is greatest when the chlorine demand is lowest; time of contact following chlorine application is important only up to 2.5 minutes; chloro-peptones and chloro-proteins are neither inhibitory nor germicidal, but other chloro-products formed in sewage create a progressive reduction of bacteria with increasing time of contact, such as for instance in travel through trunk sewers and sedimentation tanks.

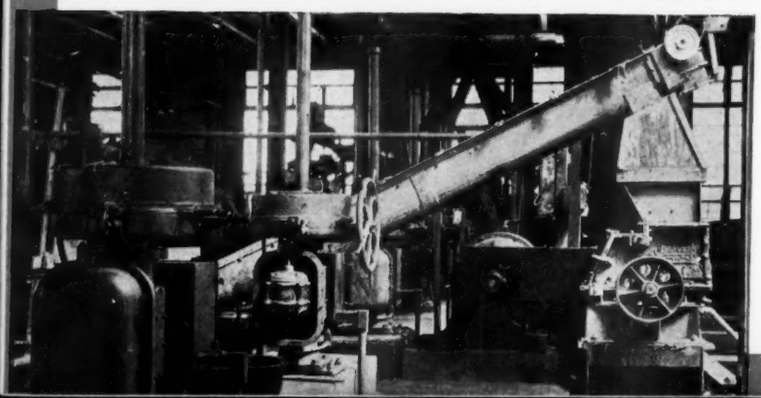
Rudolfs found absorption of chlorine by sludge quite rapid during the first half-hour, during which time 80% of the organisms were destroyed, and 97.8% were killed at the end of 6 hrs., but the remaining 2.2% were highly resistant to chlorine attack, even after 24 hours.

Several plants are making ferric chloride at the point of use. The Scott-Darcey plan, used at Oklahoma City, Fairview, Perry and Enid, Okla., and Essex Fells, N. J., uses tin cans as a source of iron, the cans being placed in a concrete tower with a chlorine solution entering at the bottom. The mixture of ferrous and ferric chloride solution which flows from the top is completely oxidized to ferric chloride by a further addition of chlorine as it flows through a pipe line to the point of application.

Experimental plants have been testing out the Lewis, Streander, Stevenson, Miller-Koller, Putnam, Cabrera and Diamond Alkali Co. processes, but these apparently are still in the development stage.

PROVE

For Handling SEWAGE and G



The many recent Sewage and Garbage Disposal Plant installatio by Jeffrey prove that it pays to select equipment with a reput tion . . . for over 50 years Jeffrey has specialized in the desig and manufacture of material handling machinery of all kinds.. equipment with all the economies of present-day operation .. equipment that has been designed especially to meet and answ your problems.

Jeffrey has a Sanitary Department whose Engineers are co stantly devoting their time to working out the best and mo improved method to adequately and effectively handle your di posal problems.

The most recent developments by Jeffrey are:

Improved Self-cleaning Bar Screen (Patent Pending), which insures a efficient and thorough screening of sewage.

A positive Discharge Flight (Patent Pending) for Sludge Collectors, whi dumps through an angle of 90° thus positively discharging the accumulat sludge in front of the flight into the sludge hopper instead of bringing to the surface as is the case when the flights are attached in a fix position to the chain.

Screenings Grinder, a machine actually reducing the screenings to a pu which readily passes through the pumps and sinks in the settling tank

This Grinder does not tear the screenings into long strings or strips th will eventually clog the pumps.

Green Garbage Grinder, a new process developed to easily and inexpe sively dispose of green garbage by grinding; after which it is discharge into the city sewerage system. (Process Patented)

Some recent Jeffrey installations (see illustrations at the left) include those in York and Lancaster, Pa.; Houston, Texas; Mari etta, Ga.; Cleveland, Amherst, Akron, and Orrville, Ohio; Balti more, Md.; Ft. Atkinson, Wis.; Lake Placid and Saranac Lake N. Y. Jeffrey Sewage and Garbage Disposal Equipment is effect ing savings in costs in all of these plants.

Why not let our Sanitary Engineers help you solve your problem in the handling of Sewage and Garbage. They will submit their recommendations . . . without obligation on your part. Write today.

THE JEFFREY MANUFACTURING CO

947-99 North Fourth St., Columbus, Ohio

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JEFFREY

EQUIPMENT

GARBAGE

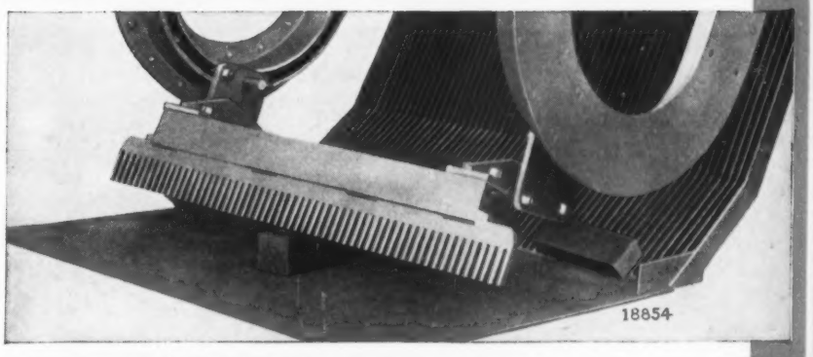
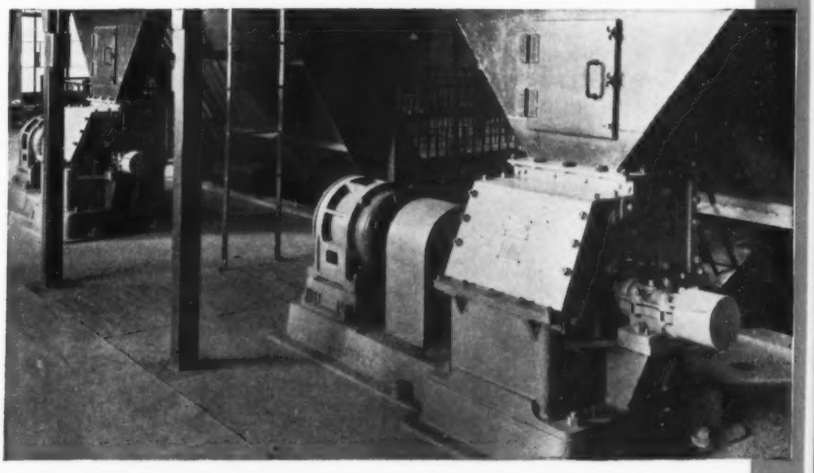


Illustration (top-right) shows a recent Jeffrey installation of a Self-cleaning Bar Screen and Screenings Grinder in a large Municipal Plant. An average flow of 16 to 20 million gallons is being handled on this job per day.

A section of the Jeffrey Bar Screen, showing the hinged scraper mechanism, is shown at the right. This special hinged scraper prevents jamming of the mechanism from accumulation of foreign material in the bottom of the channel or upon the screen.

Below the screen section may be seen an installation of two Jeffrey Screenings Grinders. Next below is shown an interior view of a primary settling tank looking toward the effluent end.

The two smaller views below show the foot end of two Jeffrey Grit Channel Conveyors installed in a large plant, and a Jeffrey Green Garbage Grinder installation.



Jeffrey Equipment for

SEWAGE DISPOSAL PLANTS:

- Bar Screens
- Grit Channel Conveyors and Washers
- Sludge Collectors
- Screenings Grinder
- Dried Sludge Grinder

GARBAGE DISPOSAL PLANTS:

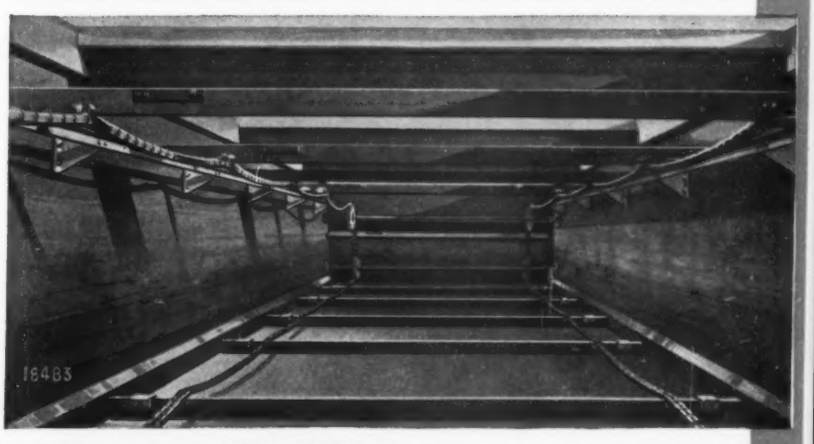
- Conveyors and Elevators
- Green Garbage Grinders

REFUSE DISPOSAL PLANTS:

- Conveyors and Elevators
- Shredders for Refuse and Paper

LIGHT AND POWER PLANTS:

- Complete Coal and Ash Handling Equipments
- Coal Crushers and Pulverizers
- Water Screens



Detailed Information on any of above will be sent upon request.

Sewage and Garbage Disposal Equipment

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

The Digestion Tank

NOTE: Reference numbers refer to the Bibliography which follows these abstracts.

PERCOLATING filters at Reading, England, recently put into service, are 9 ft. deep.[D7-4] They treat sewage which, by means of sedimentation tanks and balancing tanks, is maintained fairly uniform in character and rate of flow; and which is given partial activated sludge treatment whereby 20% of the albuminoid nitrogen is removed. 3,600,000 g.p.d. (British) is treated on 2 acres of beds, "experiments having proved that partial treatment in the activated sludge plant will enable the effluent to be treated by a 9 ft. depth of medium with as good a result as by the usual 5 ft. or 6 ft. depth, working with equal volumes per cubic yard" and that "the bottom of the bed was doing as much work as the top." The activated sludge process would do the clarification much quicker than the filters, while the filters would perform the nitrification better and quicker, said Mr. Parsons. The filter beds are not given any periods of rest. Eight thousand gallons of gas liquor entered the sewage at a uniform rate throughout the 24 hrs. and "under certain conditions, a small amount of gas liquor was more an advantage than otherwise."

Comparison of aeration systems used in the activated sludge process is logically made by determining the "purification capacity" of each (the number of grams "oxygen demand" which can be satisfied by 1 cu. meter of aeration tank per hour, with complete stabilization of the material). The author[C7-3] develops a procedure for doing this, but states that a complete investigation for a given sewage "would require a number of years of intensive work," but when the first part of the program "has been worked through once at a given research installation, where the sewage is not too abnormal, results will be obtained which will shorten the procedure very materially." One conclusion stated by the author, subject to confirmation by a series of experiments, is that "Diffused air aeration is more unfavorably influenced by colloidal organic matter in sewage than surface aeration" when comparison is made with oxygenation results using clear water.

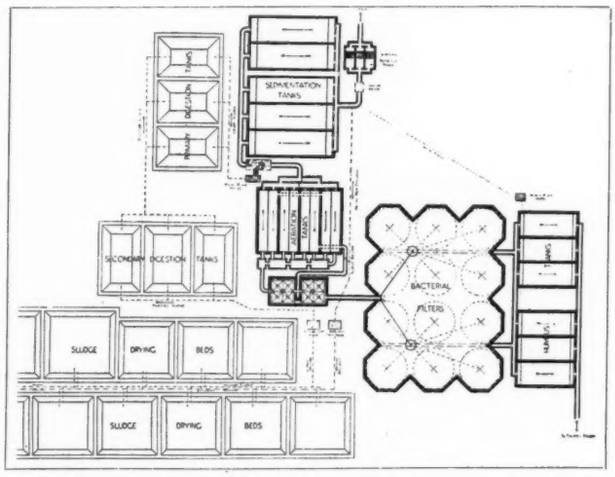
Measuring sludge with a tipping bucket meter was developed in Aurora, Ill.[H7-1] to measure sludge delivered from clarifiers to digestors. The bucket, of steel plates, receives sludge over a weir, and in tipping, discharges it into a concrete pan; one side shooting about 100 cc each time into an opening to a sampling tank. It tips once in approx. 11 seconds, 1.49 cu. ft. per bucket cycle. Once a week it is calibrated by discharging into a tank. The contents of the sampling tank are analyzed after each pumping period. The number of bucket tips is automatically recorded by a counting device. After 7 months' operation the device is considered most satisfactory, giving accurate measurement of sludge, continuously representative sample for analysis, sludge continuously visible, mechanically simple, easily kept clean.

Revenue from activated sludge effluent is obtained by Herington, Kans.,[G7-1] a railroad company paying the city 5 cts. per 1,000 gal. for boiler water and accepting the entire effluent of the plant with city water amounting to 20% additional to make up the required quantity. The revenue covers all disposal costs plus that of pumping into the railroad's elevated tank. This plant, built with R. F. C. funds, went into service in Nov. 1933.

Sludge digestion tanks at Reading, England, recently put into service, were designed for a dry-weather flow of 3.6 mgd from 100,000 population.[D7-4] There are three primary digestion and three secondary digestion tanks, all open tanks with earth banks sloped 1½ to 1, with a capacity of 5 cu. ft. per capita. The primary tanks are 14 ft. working depth; the sides are lined with 2" precast concrete slabs, the bottom unlined "as the tanks will be in continual use." The secondary tanks are 6 ft. 9 in. working depth, sides lined like the primary tanks, and the bottom also lined with 6" concrete "as these tanks will be periodically emptied." Sludge is discharged into the primary tanks 4 ft. below normal surface level, and withdrawn 2 ft. above floor level, to be discharged by gravity into the secondary tanks below surface level and withdrawn from them through an outlet sunk in the floor and pumped onto drying beds with an area of ¼ sq. ft. per capita. (Sludge from either set of tanks can be pumped back to the sedimentation tanks.)

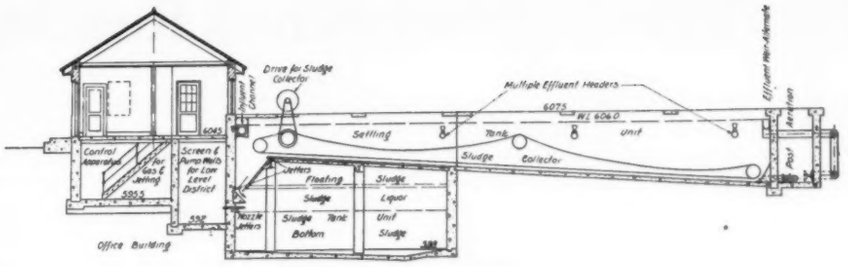
The borough engineer, A. S. Parsons, does not believe in going to the expense of heating tanks, but rather in cheaply built open tanks of large capacity sufficient to give the required digestion during the warmer months. "The fewer mechanical contrivances he had under his control the better he liked it."

A sludge digestion design with unusual features has been developed by Henry W. Taylor,[G6-2] where the crude sewage is necessarily pumped to settling tanks or there is sufficient gravity fall from tank to outlet. About 40% of the inlet ends of the two parallel settling tanks



Reading (England) Manor farm sewage treatment works

lie over and form a roof for the digestion tank, protecting this from cold air. The settling tanks are 4.5 ft. deep at the inlet end and 6.75 at the outlet end. A sludge collector draws the sludge to the inlet end, where the hopper, 5 ft. deep, has an opening in the bottom through which the sludge drops into the digestion tank, which opening is provided with an Imhoff slot to prevent escape of gas, which is collected in gas domes, one on each side of the digestion tank, which extends a few feet beyond each side of the settling tanks. Jets of heated sludge liquor will heat the sludge in the digestion tank and provide agitation.



From "Water Works & Sewerage."

Longitudinal section through digestion tank plant

In the settling tanks, effluent headers (similar to wash-water troughs in rapid sand filters) are placed just beyond the third, half and seven-eighths points of the tank length, the first to remove about 15% of the effluent, the middle one 35% and the last one 50%; the first removing sewage after 0.8 hour in the tank, the second after 1.6 hours, and the third after 4.5 hours. This gradual withdrawal, combined with increasing depths, gives very low velocities at the outlet end, favoring deposits of the lightest sludge particles. Supernatant digestion tank liquor automatically rises through the Imhoff slot into the settling tanks.

This design gives a 20% reduction in amount of concrete required and considerable reduction in miscellaneous costs.

Bibliography of Recent Sewerage Literature

c, Indicates construction article; *n*, note or short article; *t*, technical article.

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

C 7 — *Sewage Works Journal* — *May*

1. *t.* Effect of Temperature and Seeding on Hydrogen Sulphide Formation in Sewage. By Wm. H. Baumgartner, pp. 399-412.
2. Apparatus for the Determination of Dissolved Oxygen in Sludge-Sewage Mixtures. By E. J. Theriault and P. D. McNamee, pp. 413-422.
3. *t.* Comparison of Aeration Systems for the Activated Sludge Process. By H. J. N. H. Kessener and F. J. Ribbius, pp. 423-443.
4. Filtration and Incineration as a Means of Sludge Disposal. By G. P. Edwards, pp. 444-449.
5. Results of Six Months' Operation of Chemical Sewage Purification Plant. (Chicago.) By Geo. H. Gleason and Alfred C. Loonam, pp. 450-468.
6. The Mechanization of Sewage Treatment. By Edmund B. Besselievre, pp. 469-488.
7. Operation of the Sewage Treatment Plant of the Decatur Sanitary District. By W. D. Hatfield, pp. 489-503.
8. Utilizing Existing Sewage Works to Best Advantage. By A. H. Wieters, pp. 504-509.
9. Prechlorination of Sewage for Odor Control. By P. J. Houser, pp. 508-514.
10. Application of the (Iowa) Sewer Rental Law to New Construction. By Howard R. Green, pp. 514-517.
11. Experiments in Trickling Filter Ventilation. By Max Levine, pp. 517-520.
12. Sewage Sedimentation. By A. H. Wieters, pp. 520-525.
13. Biologic Filtration. By W. E. Galligan, pp. 525-529.
14. Sludge Digestion. By C. H. Currie, pp. 529-530.
15. The Aurora (Ill.) Sanitary District Plant. By Walter A. Sperry, pp. 531-541.
16. Laboratory Control of Sewage Treatment Plants. By Jack J. Hinman, Jr., pp. 541-546.
17. *t.* Sulphur in Sewage. By W. S. Mahlie, pp. 547-579.
18. Milk Waste Treatment Studies in Wisconsin. By H. Ruf and L. F. Warrick, pp. 580-595.
19. The Pollutional Character of Flax Retting Wastes. By E. F. Howard, G. W. Gleeson and F. Merryfield, pp. 596-600.

D 7 — *The Surveyor*

May 18

1. The Importance of Sewage Measurement, p. 535.

May 25

2. Aeration of Sewage. By Gilbert J. Fowler, p. 573.

June 1

3. Sewerage Work at Tunbridge Wells. By Hugh P. Bishop, pp. 597-598.

June 8

4. Manor Farm, Reading, Sewage Disposal Works. By A. S. Miller and E. S. Benson, pp. 611-612, 616.

E 7 — *Engineering News-Record* — *June 7*

1. Modernizing and Enlarging an Activated Sludge Plant (Hagerstown, Md.). By Ernest W. Whitlock, pp. 733-737.

G 7 — *Water Works and Sewerage* — *June*

1. The Utilization of Sewage. By N. T. Veatch, Jr., pp. 177-178.
2. A New Method of Sludge Drying (Spray Drying). By John R. Downes, pp. 210-211.
3. Adapting the Electric Eye to the Control of Sewage Treatment Plants. By Floyd A. Hoffman, pp. 214-215.
4. Friction Coefficient of Cast Iron Sewer after 30 Years' Service. By Alexander Potter, pp. 220-222.
5. New England Sewage Works Ass'n Meeting, pp. 223-227.

H 7 — *Municipal Sanitation* — *June*

1. Novel Method of Measuring Sludge, pp. 188-189.
2. Sanitation in Shanghai, China. By Isador W. Mendelsohn, pp. 170-173.
3. Changes in Chicago's Sewage Plans Recommended to PWA, p. 194.
4. Operating Results of the New Hagerstown Sewage Plant. By H. E. Rhodes, pp. 199-200.
5. Sewage Plant Operation Discussed at N. E. S. W. A. Meeting, pp. 201-202.

I 7 — *Pipe Progress* — *May*

1. Cast Iron Pipe Used in CWA Outfall Sewer, pp. 3-5.

J 7 — *American City* — *June*

1. Sewage Disposal Plant Designed for Economical Operation. (Ft. Atkinson, Wis.) By Robert Cramer, pp. 78-79.

L 7 — *Civil Engineering* — *June*

1. Los Angeles Incinerates Sewage Screenings. By H. G. Smith, pp. 293-295.

M 7 — *Canadian Engineer*

May 22

1. Chemical Precipitation in Sewage Treatment. By Alexander Potter, pp. 18-19.

June 5

2. Water Gauging for Kaplan (Turbine) Units of High Capacity. By J. M. Mousson, pp. 3-7.

P 7 — *Public Works* — *June*

1. Storm Sewer Installation by Relief Work. (Newton, Kans.) By K. L. Brode, p. 31.
2. PWA Recommendations for Chicago Sewerage, p. 37.
3. Rational Storm Drain Design Practice in Los Angeles, pp. 38-40.
4. Drying and Incineration of Sewage Sludge. By Alden E. Stilson, pp. 53-54.
5. *n.* Sanitation in Sioux City, p. 54.

Q 7 — *The U. S. Piper* — *June*

1. Cast Iron Pipe in the New Easterly Sewage Disposal Plant at Cleveland, pp. 24-28.
2. Sewerage System for Bowling Green, Ky., Uses Cast Iron Pipe. By J. T. Campbell, pp. 30-32.

T 7 — *Technical Sanitaire et Municipale* — *April*

1. Les Methodes Modernes de Garde et d'enlevement des Residus Menagers dans les Villes. By Raymond Standaert, pp. 74-79.
2. L'Epuration des Eaux de l'Espierre et de la Vesdre, pp. 79-83.
3. Amenagement des Sources et Forages en Vue du Prelevement de Leurs Eaux Destinees a l'Analyse. By MM. Dienert and Guillud, pp. 83-85.

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1. Small Town Sewage Disposal Plants. By E. F. Niles, p. 87.
2. Construction and Operation of a Dunbar Type Filter. By S. M. Fields, pp. 87-90.
3. The Use of Ferric Chloride in Sewage Treatment. By W. A. Simmons, pp. 90-93.
4. Application of Oxidation Principles to Small Town Sewage Disposal Plants. By Clyde C. Hays, pp. 93-98.
5. Uses of Aluminum in Sewage Disposal Plants. By R. C. Wilson, pp. 99-102.
6. Municipal Sanitary Status in Texas, Jan. 1, 1934. Water, Sewerage, etc., in each of the 1200 towns, pp. 141-168.

XX 7 — *Miscellaneous*

1. Purification of Creamery Waste in Filters at Two Iowa Creameries. Bulletin 115, Iowa Engineering Experiment Station, Apr. 4, 1934.
2. Effect of Bottom Ventilation on Purification by an Experimental Trickling Filter. Bulletin 116, Iowa Engineering Experiment Sta., Apr. 11, 1934.

Roadside Improvement is Required on Federal-

UNTIL comparatively recent years, roadside improvement was considered a luxury to be confined to parkways and other "show" highways; in 1912 Massachusetts began to adopt it for some of its state highways; and in 1933 a certain amount of it was made compulsory on Federal-aid highways, the Chief of the Bureau of Public Roads ruling that each State highway department must "include in its program of construction on the Federal-aid highway system a definite number of projects that will provide for the appropriate landscaping of parkways or road sides." No maximum limit has been set on the amount of Federal funds available to a state that may be used for roadside work, but the state highway departments have been notified that at least 0.5 per cent of the sum allotted to each state must be spent for such purpose, and is the minimum acceptable under any circumstances.

Also the rules and regulations for construction under the NIRA $400,000,000 highway appropriation list near the top of classes of work worthy of prior consideration "the appropriate landscaping of parkways or roadside on a reasonably extensive mileage."

The Bureau of Public Roads, to facilitate compliance with its requirement, has just issued Circular No. 191, entitled "Roadside Improvement" (for sale by the Superintendent of Documents, Washington, D. C. at 5 cents a copy), in which 35 pages are devoted to explaining why and how such improvements are to be made. The statements and illustrations presented herewith are based upon this circular, which was prepared by Wilbur H. Simonson, Senior Landscape Architect, and R. E. Royall, Senior Highway Engineer, of the Bureau. (See also PUBLIC WORKS for March, April and May.)

Reasons for Roadside Improvement

Highway traffic is to a considerable extent recreational. Those attracted to the open country desire attractive roadsides because of a love of natural beauty. Tourist traffic will seek the routes of greatest beauty, as it always has in the past, and leave money behind in payment for gasoline, meals, lodgings, garage services and incidental expenditures, which makes it worth while to please them. (It is estimated that highway tourists spent $274,000,000 in Michigan in one year.) Mere mileage, even supplemented with smooth pavements, low grades and easy curves, no longer satisfies an increasing majority.

Above—Planting to screen an unsightly background. Below—Transplanting from area to be occupied by the roadway a fine cedar well worth using along roadside.

Natural growth of wild rice along the highway. Such native growth requires no introduced planting and furnishes excellent refuge for wild life.

What It Comprises

The Bureau's regulations above referred to state that: "This work shall embrace the selective cutting or pruning of existing growth, the removal of stumps, dead material, etc., the obliteration of borrow pits, traces of old roads and other construction scars, the flattening of slopes, the rounding of slope intersections, the seeding or sodding of shoulders and slopes, and the planting of a sufficient amount of suitable material to accomplish a reasonably comprehensive roadside improvement. The planting of trees at regular intervals without regard to their environment or to the composition of adjacent plant growth will not be considered as satisfactory roadside improvement work."

Adequate right-of-way is essential. It "should be sufficient to accommodate the future surface width and a landscaped area safely beyond the space required for any future widening. . . . On main highways a right-of-way not less than 150 feet wide seems desirable to meet probable future requirements. . . . In certain places considerably greater width may be desirable, especially where there is opportunity for a particularly effective landscape development, such as the preservation of a natural grove of trees, or where it is desired to plant screening material to hide an unsightly area."

Projects may vary considerably in length, but the Bureau desires that this be not less than one mile, nor generally more than 10 to 15 miles; about 5 miles seems to be a desirable average. "A reasonable length is necessary for economy in design and supervision and for effectiveness in results."

Projects should contemplate complete development ultimately, but immediate work can be limited to grading, advance preparation of the soil and seeding, the

Aid Highways and Is Desirable on Others

planting of nursery and other stock being deferred till a later time.

Much of the natural growth along the highway should be conserved, such as a particularly fine tree or clump of trees. By developing existing growth it is possible in some situations to develop extensive sections of a project, or even a whole project, without the addition of ma-

Gray birch, with brush and lower limbs removed for trunk emphasis. A simple and inexpensive treatment.

terial from outside the project. Shrubs and even trees within the area of grading operations may often be transplanted and produce effective results. Clumps of standing trees should often be cut and thinned. Topsoil should be saved and spread over the poor soil of cuts and fills, especially in rocky and gravelly areas.

"The uniformly steep slopes of cuts and fills that have been used in the past are not desirable. They are unsightly and difficult to maintain. At curves, a steep cut slope often reduces visibility to the danger point. On fills, a steep slope greatly increases the traffic hazard and forces the erection of guard rails. Flatter slopes are needed to prevent erosion, to permit seeding and sodding, and to improve appearances."

What It Costs

"Of every dollar expended on an average surfaced highway, 30 cents would be spent for grading and drainage, 55 cents for surfacing, 5 cents for engineering, 5 cents for right-of-way, and from 3 to 5 cents for roadside improvement."

"The cost of roadside improvement is not absorbed largely in the purchase and planting of trees and shrubs. Of the average dollar expended, about 10 cents will be necessary for detailed planning and supervision, 15 cents will be expended for conservation of existing growth, 32 cents will be required to prepare the ground for seeding and planting, 10 cents will be required for contingencies (such as watering during droughts), and only 33 cents will be spent for the purchase of plants and seeds and the actual planting."

State Organization for Landscaping

Satisfactory roadside improvement can be obtained only under the direction of men trained in landscape and horticultural work. Highway engineers can doubtless apply many of the principles which have been developed, such as those affecting grading operations, but they have neither the time nor the training required for landscape work. Landscaping considerations will affect highway location, clearing on new locations, grading and construction, and there should be a chief landscape architect working with the various engineering divisions in formulating standard plans.

Where work must be planned immediately and there is no landscape organization, it may be desirable to employ the services of a consulting landscape architect to direct the work. A permanent organization should be effected as soon as practicable.

A comprehensive program may require a landscape architect in each district office and trained men working under his direction in accordance with the number of projects. The landscaping forces, varying in size with the extent of the program, will work in close contact with the regular engineering forces from the inception of a project, through the planning stage and during construction. The final preparation of soil, seeding and planting generally will follow construction operations. Besides directing the original improvement, the landscape personnel should also supervise the maintenance of the plantings. The work may be performed by the regular road-maintenance forces or by special forces employed solely for landscape work.

State highway departments vary considerably in the details of their organization. All of them, however, coordinate the activities of specialists in various lines, such as surveys, bridges, materials, and construction of surfaces, and landscaping should be included.

Top—Wild undergrowth on highway location. Trees to be saved have been marked. Middle—Same location with clearing and rough grading completed. Bottom—Completed project. Location fits natural contours. Note rounded slopes, absence of ditches, rustic guard rail and result of selective cutting. Ground is seeded but sod not yet established.

Pennsylvania Bituminous Penetration Surface Course Specifications

The specifications adopted by the Pennsylvania Department of Highways, April 20, 1934, covering the construction of bituminous penetration surface course and known as PM-2; are as follows:

DESCRIPTION.—The surface course shall consist of a two (2) inch, after final compression, one (1) course wearing surface, composed of broken stone and bituminous binder cold application, constructed on the prepared base course, in accordance with these specifications.

Materials

The bituminous materials to be used in this work shall be a cold application, and shall conform to the requirements as specified in Bulletin 25 (January, 1934 or subsequent revision thereof) and shown on the plans or otherwise approved. If DH-2 and DH-3 material are used the specific viscosity at 50 degrees C. for the mixture shall be within the following limits, 26-36, as designated by the engineer.

Coarse stone for the surface course shall be uniformly graded and shall conform to the requirements for mechanical analysis specified for Pennsylvania No. 2B.

Stone chips. to be used on the seal coat shall be uniformly graded and shall conform to the requirements for mechanical analysis specified for Pennsylvania No. 1B aggregate.

Quality of Stone: All stone used shall conform to the requirements as specified in Paragraph 75 of the Specifications and Contract, Form 408, dated April, 1930. All stone used shall be free from dust, dirt, foreign materials and coatings of any character.

The contractor shall provide an approved platform weighing scale of at least two hundred (200) pound maximum capacity for the purpose of making field tests of coarse aggregate.

Construction Methods

Shoulders constructed prior to the pla ing of the base course and properly shaped may be used in lieu of forms for construction of surface course.

Lines and Grades.—The contractor shall furnish and use a template cut to the crown of the finished surface course for checking crown and contour. The contractor shall furnish and use straight edges, sixteen (16) feet in length for testing irregularities in surface course except that a ten (10) foot straight edge may be used on vertical curves. Any irregularities more than one-quarter (¼) of an inch shall be corrected as directed by the engineer.

Spreading the Stone. The prepared base course shall be cleaned of all foreign substances. String lines shall be set on each side of the road along the edges of the proposed pavement at the elevation of the top of the loose stone for this course. These lines are to be removed prior to rolling the stone. At least four (4) sets of five (5) blocks of a depth equal to the depth of the loose stone (two and three-quarters inches), spaced twenty-five (25) feet apart shall be used as a guide for the further control of the depth of the surface course. One block shall be placed at each edge of the road under the string lines, one at the center and the remaining two equidistant between the center block and each side block. These blocks shall be used also in conjunction with the crown board and straight edge.

In lieu of blocks, templates or crown boards with a metal or other approved extension attached to each end may be used so that the bottom of the template or crown board will be at the elevation of the top of the loose stone of the surface course. At least three (3) such templates must be furnished and they should be spaced at twenty-five (25) foot intervals. The stone shall then be spread by means of approved stone spreaders or directly from trucks when such work is handled satisfactorily, so as to spread the stone to a depth of two and three-quarter (2¾) inches. All segregated, fine or coarse material shall be removed and replaced with well graded material.

The depth of loose stone shall then be carefully measured to see that it is uniformly spread not less than two and three-quarter (2¾) inches in depth, and the quantity of stone shall be carefully checked by the weight of stone used. Any deficiency shall be corrected by the addition of stone. The stone shall then be shaped to a uniform contour, and when so required by the engineer, shall be set by light rolling.

Application of Bituminous Material

No bituminous material shall be applied unless the entire surface course is in a condition to permit of satisfactory penetration and adhesion. Any of the surface course stone which has become coated or mixed with dirt or foreign substances shall be removed and replaced with clean stone.

After the stone has been prepared as above specified there shall be spread over the surface from one (1) to one and fifty hundredths (1.50) gallons per square yard of bituminous material in three (3) applications.

The bituminous material shall be spread evenly in all applications by an approved pressure distributor. The length of the road surface penetrated with bituminous material shall be gauged by the facilities for handling same, dependent upon labor and equipment on the project, so as to obtain proper compression and spreading.

The first application shall be from seven-tenths (0.7) to one (1) gallon of approved bituminous material made in one (1) or two (2) applications as required and the surface then dragged and rolled with a ten (10) ton roller to a uniform cross-section and allowed to dry as required, but not less than twenty-four (24) hours. Not more than eight-tenths (0.8) of a gallon of bituminous material will be used in the first application except when stone of a rough surface texture is used, which requires additional bituminous material for coating it.

Immediately there shall be spread uniformly from ten (10) to fifteen (15) pounds per square yard of Pennsylvania No. 1B chips, followed by the *second application* of bituminous material at the rate of twenty-hundredths (0.20) to twenty-five hundredths (0.25) gallon per square yard, as directed by the engineer. The surface shall then be covered with from eight (8) to ten (10) pounds per square yard of Pennsylvania No. 1B chips and the surface thoroughly rolled.

At the proper time, as directed by the engineer, according to the conditions, the *third application* of bituminous material at the rate of twenty-hundredths (0.20) to twenty-five hundredths (0.25) gallon per square yard and from fifteen (15) to twenty (20) pounds per square yard of Pennsylvania No. 1B chips shall be placed, as directed by the engineer, and the whole surface finished by rolling until the chips are thoroughly imbedded.

Finishing the Surface

When the surface is completed, any irregularities shall be remedied to the satisfaction of the engineer by loosening the surface and removing or adding stone and bituminous material as may be required, and rolling continued until it is compacted satisfactorily to a uniform surface. The rolling of the whole surface shall be continued from time to time, as required by the engineer, until the bituminous material has hardened satisfactorily. The contractor shall not haul heavy loads over the completed surface and any damage caused by contractor shall be repaired satisfactorily at his own expense. Ashes and cinders from fire boxes shall not be dumped on the surface.

Basis of Payment

This work will be paid for at the contract unit price per linear foot of roadway surface, or per square yard, of bituminous penetration surface course, Specification PM-2 as provided, complete in place, which price will include all materials, equipment, tools, labor, and work incident thereto.

Applying bitumen on a penetration macadam

The Water Wheel

Following are the essential features of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form and condensed and interpreted. Reference numbers refer to the Bibliography which follows these abstracts.

FILTER mudball formation is prevented in Evansville, Wis., by a surface wash piping system.[E6-3] The filters are 9 ft. 2 in. x 12 ft. 9 in., 9 ft. deep, with sand of crushed quartz 0.55 mm at the top. The surface wash system consists of ¾ in. pipes spaced 15⅜ in. apart, supported 2 in. above the top of the sand, in which 5/32 in. holes are drilled on 6 in. centers directed 30° below the horizontal. High-pressure jets from these holes, applied just before the regular wash water is turned on, agitate the sand during washing, and are shut down about 1 minute before the end of the wash.

Effective size of sand determination by the Hazen method has some serious objections, and a substitute method is proposed by Baylis[G6-6] which is claimed to be not complicated, not differing so widely from the Hazen method that past work cannot be compared fairly accurately with the new method, and to give the true effect of the size and uniformity of the sand on filtration. It uses sieves for determining the size of the sand grains but takes into consideration a combination of sand sizes for determining the effective size, "based upon the average of the 1, 2, 4, 8, 16 and 32% sizes (% size refers to the percentage by weight finer than the diameter to which reference is made. The 1 per cent size means that 1% of the weight is finer), except that maximum size used in the average is 1.5 times the 1% size. The uniformity coefficient is the percentage of the material having a diameter less than 1.5 times the 1 per cent size." In determining the effective size of sand from filter beds in service, take a sample from the top 6″ of the filter for determining effective size. The average length of filter run for any sand is believed to vary between the 2.0 and 2.5 power of the diameter of the effective size, depending on the clogging rate of the water. "This method gives the true effective size, in so far as it applies to the lengths of filter runs."

Jute for caulking joints should be sterilized before use,[DD7-4] by soaking for at least 30 min. before using in a solution of one tablespoon of calcium hypochlorite to a gallon of water; preferably keep jute in the solution until used.

Automatic zeolite softener "is the latest step in a continuous development of zeolite equipment for the softening of water."[A7-5] A fully automatic industrial softener has been developed to regenerate on time and regulate the cycles of backwashing, salting and rinsing with a minimum of salt and water. "The design now in successful use . . . employs a multiport single valve having a rotary flat disc, of which the ports are so arranged that by turning the disc to four successive positions the four operations of a complete cycle are carried out, and the control mechanism is so arranged that the duration of each operation of the complete softening cycle can be separately adjusted and controlled. The valve is rotated by an electric motor through a gear drive and the valve stops after reaching the correct positions for each operation." Automatic softeners, since they automatically regenerate when necessary, can be made smaller than the manually operated for same capacity, thus saving in first cost. The automatic features can be applied to any existing manual softener.

Softening water in which the total hardness does not exceed 75 ppm with lime is amply justified for an entire community, but treating with caustic soda for the neutralization of carbon dioxide, thereby preventing corrosion with avoidance of an increase in hardness, in order to reduce soap consumption and save expense in preparing boiler feed water is not justified in a public water supply of this type.[F6-9]

The cost to steam generating plants for the treatment of boiler feed water to overcome the excessive hardness due to lime treatment is about equal to the additional taxes they would have to pay should the entire city supply be treated with caustic soda. This ratio would vary with local conditions in a given community.

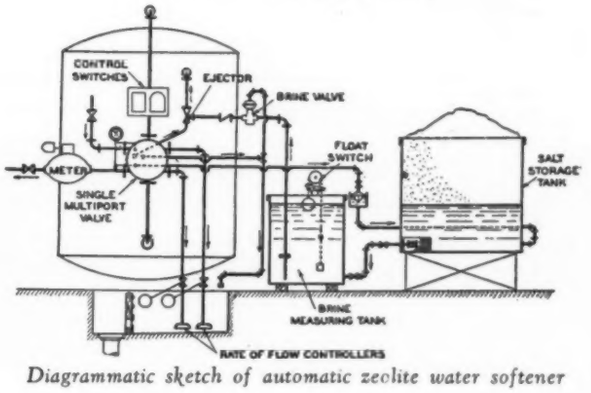
Laundries would generally be direct gainers by the caustic soda treatment, but, as their increased cost is small, there can be no justification in taxing an entire community for the benefit of a few.

The increased burden to the householder for caustic soda treatment would in most instances be about equal to the present soap waste cost caused by lime treatment. This ratio is, of course, governed by the individual use of water for washing purposes. As a considerable amount of soap is discarded in household use, any exact financial saving cannot be determined.

Economic consideration necessarily based upon more or less indefinite data indicates that the great expense of caustic soda treatment is not justified to the municipality. The cost of treating water at the plant to prevent corrosion, together with other costs to the consumer, is but a small fraction of the losses sustained should corrosive water be supplied. It is therefore believed that corrective treatment with lime produces a water of the most economic value to the most users.

Cutting lined pipe is done with a "dog" or straight-edge chisel, a wheel cutter or a machine cutter.[B6-3] Gibson found that the wheel cutter "tends to cause the cement to break out further back into the pipe from the cut edge"; while Esty uses it up to 12″ pipe, using double chain tongs, and finds it makes a better cut than chisel and hammer and does not disturb the lining. From 14″ to 20″ pipe Esty uses hammer and chisel. Sanders also has better luck with the wheel cutter. Conard would use nothing but a machine cutter, which gives a clean cut with any kind of pipe. As to cost, he said "There is a machine cutter that is produced in Ohio for 4, 6 and 8-inch pipe which costs $75," which is hand operated and can be set up in five minutes or less.

(Continued on page 44)



Diagrammatic sketch of automatic zeolite water softener

Bibliography of Recent Water Works Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *t*, technical article.

A 7 *Journal, American Water Works Association*

May

1. Research and Investigational Studies in Water Works. By H. A. Van Norman, pp. 571-578.
2. Modern Water Chlorination Practice. By L. H. Enslow, pp. 579-589.
3. Booster Stations at Trenton Water Works. By Frank M. Winder, pp. 590-595.
4. Asbestos Cement Water Pressure Mains. By C. A. McGinnis, pp. 596-606.
5. Development of the Automatic Zeolite Water Softener. By S. B. Applebaum, pp. 607-617.
6. Progress in Municipal Zeolite Water Softening. By. A. S. Behrman, pp. 618-628.
7. The Duties and Responsibilities of a Water Commissioner. By Gordon S. Matthews, pp. 629-633.
8. *t.* Eliminating Fake Chlorine Tests. By R. D. Scott, pp. 634-640.
9. *t.* The Correlation of the Alpha-Methyl Glocoside Test for the Colon-Aerogenes Groups. By Charles F. Poe, pp. 641-644.
10. Removal of Bacterial Flora from Water in Settling Basins by Added Clay Dispersions. By Edward M. Slocum, pp. 645-652.
11. *t.* Outline of Stray Current Electrolysis. By Ira D. Van Giesen, pp. 653-671.

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12. Why Water Meters Need to Be Heat Resistant. By Geo. Read, pp. 693-703.
13. High-Lift Pumping Plant at Grand Canyon, Ariz. By Geo. L. Davenport, Jr., pp. 704-705.
14. Selection of Equipment for Electrically-Driven Pumping Stations. By S. M. Dunn, pp. 706-711.
15. Gravel Wall Wells. By R. R. Schweitzer, pp. 712-724.
16. Successful Program in Eliminating Cross-Connections. By J. S. Longwell, pp. 725-734.
17. Railroad Water Supplies. By C. R. Knowles, pp. 735-742.
18. Cotton Caulking Yarn. By W. M. Rapp and Paul Weir, pp. 743-749.
19. Lime Slaking. By E. E. Harper, pp. 750-756.
20. *t.* Photodiscoloration of Orthotolidine and Artificial Standards for Free Chlorine Test in Water. By W. S. Davis and C. B. Kelly, pp. 757-759.
21. Taste and Odor Problems at Chester, Pa. By Rennie J. Dodd, pp. 760-764.
22. Break in Supply Main Brings Permanent Improvement in the Quality of Water. By M. H. Coblentz, pp. 765-768.
23. Earthquake Effects on California Water Supplies. Long Beach. By Fred S. Porter.
    American States Water Service Co. By C. P. Harnish. Lynwood. By A. J. Bateman. The Dominguez Water Co. By E. P. Tallon. South Gate. By L. M. Rothkranz, pp. 769-787.
24. Effective Utilization of the Public Water Supply in Fire Fighting. By W. C. Mabee, pp. 788-792.
25. Income and Operating Costs for Water Supply for Various Cities for 1932. By Wm. C. Rudd and Arthur C. Michael, pp. 793-795.

D 7 *The Surveyor*

May 25

1. Disintegration of Concrete Dams, pp. 561-562.
2. The Preston Aqueduct Tunnels. By E. C. Oakes, pp. 563-565.
3. The Examination of Filtered Swimming Bath Water. By Thomas E. Mogg, p. 569.
4. A Criticism of Bath Filtration Systems. By E. H. Whittle, p. 571.

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5. The Pumping of Rural Water Supplies. By H. R. Lupton, pp. 587-589.
6. Disintegration of Concrete Dams. Discussion of D7-1, pp. 591-593.
7. Water Shortage Alleviation, p. 598.

E 7 *Engineering News-Record*

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1. Russia Creates a Great Laboratory for Hydraulic Research. By I. Gutmann, pp. 761-766.
2. American Water Works Association Convention, pp. 779-782.

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3. Bouquet Canyon Dam Built for Los Angeles Aqueduct. By H. L. Jacques, pp. 810-813.

F 7 *Water Works Engineering*

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1. Training Men for Water Supply. By Jack J. Hinman, pp. 532-535.
2. Value of Standardized Laboratory Procedure. By Harry E. Jordan, pp. 536-537.
3. Minimum Rate for Water Service. By Caleb Mills Saville, pp. 538-539, 603.
4. Cold Weather Breaks in New York. By Wm. W. Brush, pp. 540-542.
5. Cold Weather Troubles in Canada. By Ross L. Dobbin, pp. 544-545.
6. Thawing Water Pipes Electrically. By Fred Shepperd, pp. 546, 582-588.
7. Washington Completes Large Pipe Line. By Rossiter S. Scott, pp. 596, 599, 600.

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8. Boulder Dam Construction. By M. M. O'Shaughnessy, pp. 654-657.
9. Minimum Rate for Water Service. By Caleb Mills Saville, pp. 658-660.
10. American Water Works Ass'n. Convention, pp. 661-670.
11. Thawing Frozen Mains and Services. Symposium, pp. 671-672, 675-676.

G 7 *Water Works and Sewerage*

June

1. Reconditioning Large Water Mains. By Wm. W. Brush, pp. 171-173.
2. Meter Shop Practice and Inspection Program. (Newton, Mass.) By Richard H. Ellis, pp. 174-176.
3. Features of the New Water Purification Works at Burnt Mills, Md. By Robert B. Morse, pp. 179-182.
4. Water Works Kinks. By E. E. Jacobson and Clark Cramer, pp. 183-187.
5. Design of Surge Suppressors for Croton Lake, N. Y., Pumping Station. By S. Logan Kerr, pp. 207-209.
6. *c.* Inserting Gate Valves in Water Mains under Pressure. By Chas. Streithof, p. 212.
7. Results from the Use of Black Alum at the Trenton, N. J., Filtration Plant. By Joseph Y. Reid, p. 213.
8. *c.* Wrecking Elevated Water Tanks. By Carl A. Heckmer, pp. 218-219.
9. *n.* Stopping Leaks in a Cambridge, O., Reservoir, p. 222.

J 7 *American City*

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1. Installing Water Mains under Two Railroads. By C. E. Hogeboom, pp. 59-61.
2. *n.* Carthage Municipal Water Works. By C. Hoen, p. 64.
3. *n.* New Electrically Driven Pumping Station at Duluth, Minn. By E. A. Murray, pp. 65-66.
4. *n.* A Filtration Plant in Southern Michigan. By D. E. Bicknell, pp.67-68.
5. Selection of Deep-Well Pumping Equipment. By R. E. Swanson, pp. 73-74.
6. Study of Water Consumption and Metering, pp. 75-77.
7. Water Rates and Service Charges, Installation Charges, Hydrant Rentals and Sprinkler Costs, pp. 86-91.

M 7 *Canadian Engineer*

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1. Filter Sand Experiments at the Toronto Filtration Plant II. By L. F. Allan, pp. 9-14.
2. Accomplishments and Objectives of Municipal Water Supply. By Norman J. Howard, pp. 15-17.

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3. False Pressure Readings in Pumping Plants. By Prof. R. W. Angus, pp. 9-16.
4. Office Administration and Records. By C. D. Brown, pp. 17-18.
5. The "Eric" Process of Cleaning and Relining Water Mains. By S. A. McWilliams, pp. 19-21.
6. Effect of Frost in Water Works Systems. By R. H. Martindale, p. 23.

N 7 *The Earth Mover*

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1. *c.* Dam Construction in the Tennessee Valley, pp. 8-10.

P 7 *Public Works*

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1. Water Works of the Greater New York Metropolitan District, pp. 13-15.
2. Designing Elevated Water Tanks, pp. 16-17.
3. Reconditioning a 42", 42-Year Old Pipe Line, pp. 18, 20.
4. Reduction in Cost and in Leakage Obtained by Using Joint Compounds for Water Mains, p. 30.
5. Latest Procedures in Use of Activated Carbon for Taste and Odor Control. By F. E. Stuart, pp. 35-36.
6. Relief Labor in the Water Works Plant, p. 36.

W 7 *Johnson National Drillers Journal*

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1. Standards for Supplies, Materials and Construction. Report of Committee, pp. 17-19.
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3. State Dep't of Health Program re. Public Water Supplies. By J. W. Brown, pp. 28-30.
4. Problems in the Disinfection of Municipal Water Distribution Systems. By G. R. Fulton, pp. 31-36.
5. Practical Cross-Connection Program and Elimination in Small Cities. By W. N. Dashiell, pp. 36-37.
6. Taste and Odor Control in Surface Water Supply. By Geo. J. Rohan, pp. 37-38.
7. Recent Development in Water Supply Coagulation and Filtration. By Lewis O. Brenhagen, pp. 38-40.
8. Model Watershed Control Regulations. By W. F. Hicks, pp. 41-43.
9. Requirements of State Fire Insurance Commission for Securing Minimum Key Rate. By Geo. Hawley, pp. 43-47.
10. Meter Repairing. By Morris Hoenig, pp. 47-50.
11. Reservoir Construction and Maintenance. By Frank M. Murphy, pp. 50-53.
12. Installation and Maintenance of House Service Connections. By A. R. Davis, pp. 54-57.
13. Filter Sand, Wash Rate and Underdrain Systems. Summary of recent committee recommendations. By Joe Didinger, pp. 58-69.
14. Design and Construction of Small Town Aerator. By C. J. Blum, pp. 69-74.
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16. Water Sample Collection from the Inspector's Viewpoint. By W. E. Roberts, pp. 84-86.

EE 7 *Journal, Maine Water Utilities Ass'n.*

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2. Thawing Water Pipes by Electricity. By E. S. Boulos, pp. 55-58.

FF 7 *Journal, Municipal Engineers of City of New York*

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1. Sub-surface Water Supply of Western Long Island and Its Utilization. By William F. Laase, pp. 20-57.

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Don't forget the Readers' Service Dept.—pages 51-53

Incineration of Sewage Sludge

(Continued from page 13)

tively low and it requires time before they are decomposed. If, however, the sludge to be dewatered is very stale, hydrogen sulfide formation is very rapid. Odors from volatile substances other than hydrogen sulfide are usually more important in the drying.

Some odors in the drying operation are a problem essentially connected with the volatile substances. Drying at low temperatures seems required. However, drying at low temperatures (125° F) requires uneconomical amounts of heat and power. It may be possible that in one operation moisture can be reduced and at the same time volatile substances be prevented from escape. This possibility would be by utilizing a closed system with gasification or destructive distillation of the organic volatile matter and subsequent condensation of the moisture. The coked material, after breaking up, might be incinerated more readily without the production of odor.

The final step, incineration, requires undoubtedly further study. The tendency of sludge to sinter with incomplete combustion of carbon and ash can be helped in several ways, as already done in Chicago and Milwaukee. It might also be overcome somewhat by a system as indicated above. The incineration of the volatile material converted first to gas could be better controlled with complete combustion.

Some results on hand from experimental work to determine the types of gases produced when dewatered sludge is retorted, as well as the heat values of the gases, show variations from 390 to 533 B.t.u. per cu. ft. of gas produced. At a maximum retorting temperature of 900°F the sludges yielded on an average the following gases, expressed in percentages:

Carbon-dioxide	9.6%
Illuminants	0.1
Oxygen	1.1
Carbon-monoxide	7.3
Hydrogen	39.7
Methane	26.5
Nitrogen	15.7
Average B.t.u. per cu. ft.	461

It appears that the illuminants and carbon-monoxide content was lower than usually found in city gas. The hydrogen is also somewhat lower, while methane, having the greatest heat value of these different gases, was somewhat higher. However, the total heat value of the gases was lower than ordinary coal gas delivered to the consumer.

Mr. Stilson's calculations on heat balances are of considerable interest and the comparisons between sludges to which paper or chemicals are added for dewatering show clearly what may be expected for practical purposes. Too often it is forgotten that with the addition of substances that absorb water and produce an apparent lower moisture content of the resulting sludge cake, the quantities of water to be evaporated are not lowered, while the additional material has a lower heat value. In cases where paper is added, the cost of collection and preparation may be less than an addition of chemicals, but when burned the total cost may be higher. Naturally, the differences would be much greater if appreciable quantities of inert materials like clay, dust, etc., are added as an aid in dewatering.

In summarizing the problem of the preparation for and the incineration of sludges economically and without nuisances it appears to us that:

1. Considerable investigation is required to make dewatering of fresh sludges really economical and dependable. It is doubtful that this can be done without fundamental studies. Present methods have some measure of success with digested sludges.
2. Odor control and complete utilization of volatiles in the dehydration step of the problem will undoubtedly require dryers of a different design than used at present, or modified to meet the conditions. Those interested in this field have an unusual opportunity to make incineration a success.
3. It is doubtful that garbage incinerators, although they may have a measure of success for screenings incineration, can be used without material modification for dewatered sludges alone.
4. Although dewatering, drying and incineration of fresh sludges as well as digested sludges appears to be feasible, considerable investigation and field work is required before conclusions can be drawn whether or not such practice is better, more economical and simpler for smaller sewage treatment plants than the methods used at present.

George W. Fuller

George W. Fuller died on June 15th, after a brief illness, at his residence in New York City. He was an internationally known expert on water and sewage treatment and the most prominent one in this country. He was the senior member of the firm of Fuller & McClintock, of which Mr. McClintock died April 11, 1933.

Mr. Fuller was 65 years old. He graduated from the Massachusetts Institute of Technology in 1890 and later studied in the University of Berlin and with Piefke, engineer of the Berlin water works. He spent five years with the Massachusetts State Board of Health, the latter part in charge of the Lawrence Experiment Station; then about four years conducting experiments for the cities of Louisville and Cincinnati to determine the best methods of filtering their water supplies, which studies formed the basis of the development of rapid sand filtration for purifying potable supplies. He then, in 1899, began private practice in New York; from 1901 to 1911 in partnership with Rudolph Hering, and from 1916 until his death with James R. McClintock.

Meantime he acted as consultant in many important matters—the disposal of Chicago's sewage and recently of that of New York City and the water supply of that city and of Shanghai, China, Kansas City, Memphis and sewerage or water supply in 150 others; the U. S. Public Health Service, the Construction Division of the Army, the New Jersey Water Policy Commission, the Rhode Island Metropolitan Sewerage Commission, etc. He contributed largely to the development of the "Standard Methods" of the American Public Health Association and to the preparation of the "Manual of Water Works Practice" of the American Water Works Association; of both of which associations he was a past president. He was a member and past vice-president and director of the American Society of Civil Engineers, and member of the Am. Inst. of Consulting Engineers, Am. Soc. of Mechanical Engineers, Am. Chemical Society, Am. Soc. of Bacteriologists, Inst. of Civil Engineers of Great Britain, Engineering Inst. of Canada, Vereines Deutsches Ingenieure, Association Generale des Hygienistes et Techniciens Municipaux, and others.

He was the author of many professional papers and of three books—"Water Purification at Louisville"; "Sewage Disposal" and "Solving Sewage Problems."

Storm Sewer Installation by Relief Work at Newton, Kans.

A description of the installation of storm sewers in Newton, Kansas, by relief labor appeared in the June issue of PUBLIC WORKS, page 31. The cost of installing the Armco corrugated pipe used on this job was incorrectly given: the cost of unloading, laying and connecting 1,326 feet of 42-inch diameter pipe in a trench with an average depth of 6½ feet amounted to only 9.3 cents per foot of pipe. Through an error by the printer the cost was given as 93 cents per foot.

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Distilling Wastes and Stream Pollution

With the return of the alcoholic beverage manufacturing industry, a large number of brewers and distillers and their allied interests made inquiries concerning stream regulations, water supply and waste disposal facilities. The cooperation of the Department (The Maryland State Dept. of Health) has been extended by inspections of proposed locations, examinations of water supplies and studies of assimilative capacities of a number of water courses into which it was proposed to discharge the wastes. In estimating distillery waste strengths and volumes in relation to stream capacities the following figures have been used:

Average B.O.D. of waste after separation of spent grain	15,000 ppm
Total water consumption of distillery per 1,000 bushels grain per day	140,000 gpd
Whiskey manufactured	4,000 gpd
Waste from separators	50,000 gpd
Waste water—uncontaminated	90,000 gpd

At present no practical method of complete treatment, economically applicable to a distillery of average size, is available. It is hoped, however, that when some of the distilleries go into operation opportunities will be presented to conduct some experimental work leading to a solution of the waste problem.

About twenty proposed sites have been inspected. Three distilleries are in operation and construction is going on at four additional locations in the selection of which the Bureau gave assistance.

From the annual report of the Bureau of Sanitary Engineering, Maryland State Dept. of Health.

THE RED FIRE PUMP

at Bonnie Burns Sanitorium is one of the classic installations of this type of emergency power unit. Quick starting, instant readiness to serve, and a Sterling engine protect this institution, and many municipalities against power failure during fire.

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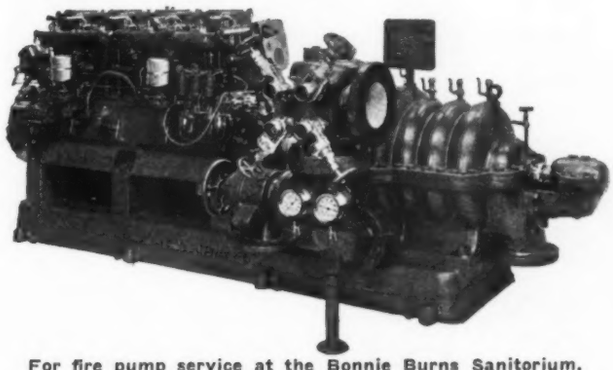

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1. PRIME COATING
2. SURFACE TREATING
3. MIXED-IN-PLACE CONSTRUCTION

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A priming material should have the ability not only to penetrate but also to bind together the aggregate through which it has penetrated.

For very tight surfaces, such as lime-rock, sand-clay, top-soil, etc., light grades of Tarmac primes have proved in actual service that they are more successful than any other material.

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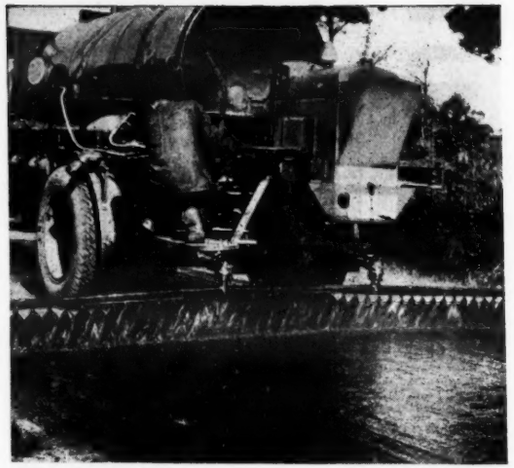

On tight surfaces use light viscosity primes—on more open surfaces use heavier primes.

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Don't forget the READERS' SERVICE DEPT.—pages 51-53

Use of Bulldozers in Highway Grading Work

*By the Division of Management, United States Bureau of Public Roads**
Reported by ANDREW P. ANDERSON, Highway Engineer

THE use of large tractor-powered bulldozers as actual excavating units and the use of large-capacity scrapers are comparatively recent innovations in highway grading. From time to time, this type of equipment has been found in use on jobs on which production studies were being conducted by the Bureau of Public Roads and the data thus accumulated will be summarized and reviewed briefly.

The bulldozer has long been standard equipment on the dump or fill, but its use in the cut as a combined excavating and hauling unit has, until recently, been very limited. All available data, however, indicate that the bulldozer and the modified type frequently known as the "trail builder" are well adapted to moving common excavation where the hauls are comparatively short and down rather steep grades and the materials are, or can be made, loose enough to permit the rapid accumulation of a load. If the material is at all hard or solid, it should be loosened with a rooter or a scarifier, or by blasting. The bulldozer is entirely satisfactory only where the ground is loose enough to permit a load to be picked up within a length of 25 to 40 feet with the tractor moving at a speed of 2.0 to 2 5 feet per second. If the material is too hard or tight to permit a full load to be picked up in from 10 to 20 seconds, it should be loosened with a rooter or by scarifying or by blasting.

Bulldozers Used in Conjunction With Power Shovel

The tractor-powered bulldozer has thus far found its widest use as an excavating unit in conjunction with the power shovel when operating in rather rough, broken country with a deep mantle of soil or deeply weathered and decomposed rocks and shales. The bulldozer has certain characteristics which appear to limit its profitable operation as an excavating implement to jobs having these general features. It is most effective in moving material down steep slopes. As the grade decreases the efficiency decreases very rapidly, and on an ascending grade the efficiency of transportation is very low.

Proper material is essential. The material must be naturally loose or at least sufficiently friable to permit rapid and direct accumulation after loosening. Hard rocks and very hard shales can rarely be shattered sufficiently for movement with a bulldozer.

A relatively short haul is the third requirement. The tendency of the materials to spill around the ends of the bulldozer blade usually makes long movements unprofitable. Unless the grade is very steep a large load at the start will soon dwindle to a small one. Where a large yardage is moved along one path a trough or trench is formed by spillage around the ends of the blade and soon becomes sufficient to reduce further spillage. This advantage of path movement on long hauls should be utilized as much as possible. Sometimes the spillage around the ends of the bulldozer blade can be reduced by working two bulldozers abreast with their blades only a few inches apart. Observations on a job where this was tried indicated that the yardage moved per trip by the two tractors was increased nearly 20 percent over that moved when working independently.

The bulldozer is particularly useful in conjunction with the power shovel. On steep ground the pioneer road work necessary for the shovel to reach the first lift of a deep cut can frequently be greatly reduced and sometimes entirely eliminated by having the bulldozer build up both an approach for the shovel and a hauling road for the trucks or wagons. Often a cut which would normally be made in two or three lifts may be reduced

At the right, beginning a cut in a notch between hills and making a fill in the foreground.

*By courtesy of the Bureau.

Bulldozers grading highways. Large loads are moved on steep grades. The bulldozer keeps in a trough which prevents spilling around the ends.

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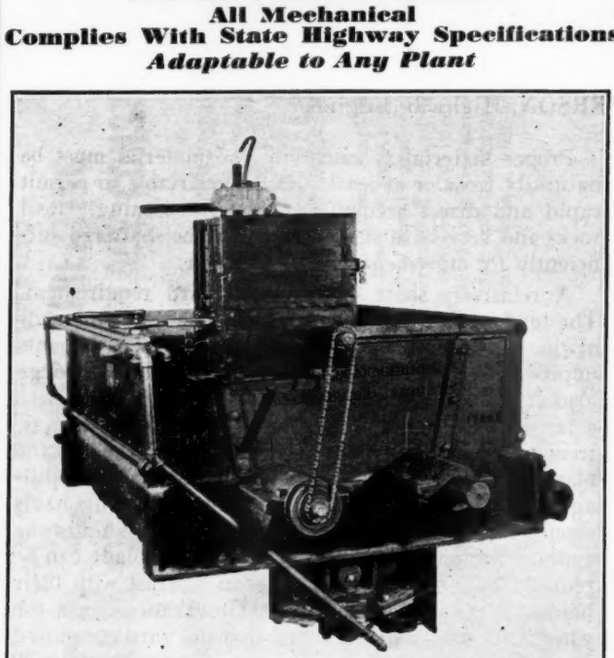

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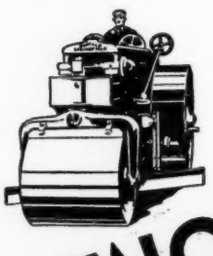

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in this way by one lift and better hauling roads provided because of the adaptability of the bulldozer to the conditions. With the bulldozer this can generally be done with the movement of only pay materials, whereas the older method frequently requires the movement of considerable quantities of nonpay materials in the construction of approach roads in zigzags up the steep slopes.

The bulldozer has been found effective in sidehill work. Work is usually begun along the upper line of slope stakes and the material moved ahead and to the side as the conditions may require. So long as the material is loose or can be loosened and the haul distance is short enough to maintain a rather steep grade along which to move the material, good production rates can be maintained.

The best operating speed at which to haul the loads is still largely a matter of opinion. The general practice is to work at about the maximum speed possible without obviously straining the power unit. This practice may be entirely correct for many or possibly most cases. It was noted during recent job studies that in moving loose, noncohesive material down steep grades the amount of material which would push or flow in front of the blade was much larger at a speed of 2 feet per second or less than for a speed of 3.5 feet per second. There appears to be some optimum speed which will yield the greatest production, at least when moving loose, noncohesive materials down steep grades. However, no definite data are available as to what this most productive speed is or how it may vary with different materials and on different slopes.

Opening a cut with the bulldozer in ground as described above is comparatively simple, although on very steep ground considerable skill and ingenuity are required in maneuvering the bulldozer in its climb to the very top of the cut. Once this point has been reached the bulldozer begins to dig along the highest point of the upper slope line. The excavated material is pushed ahead toward the fill. If the ground slope is steeper than the tractor can readily climb in reverse, the material is simply pushed clear of the immediate excavation and allowed to accumulate along the line of the hauling road until a runway is provided with flat enough grade to permit the bulldozer to return readily in reverse after delivery of its loads to the fill. If the ground slope is already flat enough for the tractor to return fairly easily, every load is carried to the fill. In both cases the slope of the hauling road for the bulldozer is kept as steep as possible because, within limits, the steeper the grade the larger the load which can be carried to the fill.

As the work progresses the runway is widened to finally include the full width of the cut. In a wide cut three or four bulldozers can sometimes be operated without interference, and even more if the haul is in both directions. If the material becomes too hard for easy loading, a heavy scarifier or rooter drawn by a powerful tractor may be used to loosen it. If the ground becomes still harder, blasting should be resorted to. The harder rocks and shale, however, can seldom be reduced sufficiently to make the use of the bulldozer profitable. When rock or ground of this nature is reached further work is left to the power shovel.

The steeper the grade the larger the load which can be carried to the fill and the longer the haul on which the bulldozer can be used profitably. The only limit to the grade is the ability of the tractor to climb on the return. A large crawler tractor in good condition and

equipped with a 10-foot standard bulldozer has been observed to climb a grade as steep as 50 per cent.

Field observations indicate that the average load which can be carried from cut to fill under ordinary field conditions varies with the length and shape of the blade, the grade along which the load is moved, and the character of the material. The observations are confirmed to some extent by the data of table 1. During recent studies of the use of four bulldozers in moving considerable yardages it was found that loads frequently fluctuated as much as 100 percent. For a certain bulldozer the smallest loads would be about 2 cubic yards, and the largest loads would be about 4 cubic yards.

TABLE 1.—*Operation characteristics of tractor-powered bulldozers*

	Bulldozer No.			
	1	*2*	*3*	*4*
Number of trips timed	3,731	511	800	560
Cubic yards placed in fill	11,741	1,655	1,822	1,352
Production rate ...cu. yds. per hr...	68.4	57.0	35.2	44.1
Pay yardage per load..cubic yards..	3.15	3.24	2.28	2.41
Loading distance .....feet..	30.0	40.0	28.0	39.0
Loading speed .....ft. per sec...	2.4	2.4	1.4	2.7
Haul distance .....feet..	168	216	309	232
Hauling speed .....ft. per sec...	3.7	3.2	3.2	3.1
Return distance .....feet..	200	260	340	275
Return speed .....ft. per sec.....	2.3	2.5	4.7	2.5
Average grade .....percent..	—26	—17	—11	—20
Operating cycle:				
Load .....seconds..	12.6	16.6	20.6	14.3
Reverse or turn at dump.....do..	1.9	2.0	2.6	2.5
Turn or shift at cut.....do..	2.0	2.4	2.8	2.4
Minor time losses, percentage of working time.....	12.6	14.5	18.0	16.2
Size of blade.....feet..	4x10	3x11.5	4x10	4x10
Rated horsepower of tractor.....	65	65	60	60

Recent improvements in control which permit independent vertical movement of either end of the bulldozer and also lateral movement have considerably improved the utility. It is easier to keep the entire cut in proper condition for easy operation, and to shape the slopes at the proper angle. These features are particularly valuable in sidehill work.

Laboratory Supervision Prevents Tastes and Odors

The quality of the water delivered to the consumers in Haverhill, Mass., during 1933 was uniformly good, according to Herbert C. Crowell, superintendent of the department: "in fact," says he in his annual report, "the average quality of the water has been considerably improved over former years. The quality of the water was checked by Metcalf & Eddy, engineers of Boston. Frequent microscopical examinations of samples of water from Kenoza Lake, Johnson Pond and Crystal Lake were made throughout the year; these examinations were made twice a month from April to October, inclusive. This close check on the quality of water prevented the excessive growth of micro-organisms that would impart unpleasant tastes and odors in the water. Applications of copper-sulphate were made to Kenoza Lake in January, April and November and to Crystal Lake in June; to Jonnson Pond in April, June and November. These treatments prevented the growth of micro-organisms and prevented bad tastes and odors in the water. I would therefore recommend that this supervision of the water in the several lakes comprising the water supply of the city be continued through the year 1934."

All the water is chlorinated using W. & T. chlorinators; a Type MSV at each of two of the ponds, and a Type A S. P. V. M at Crystal Lake, where the flow varies from 250,000 gpd at night to 1,800,000 gpd during the maximum day.

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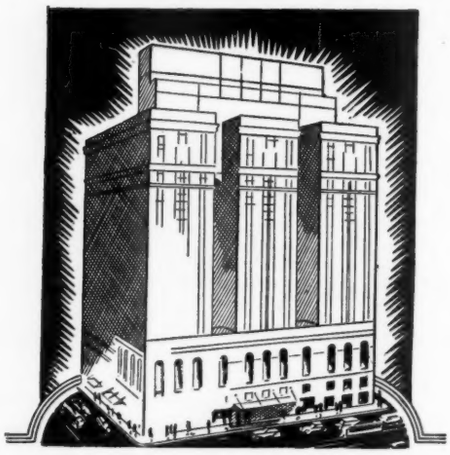

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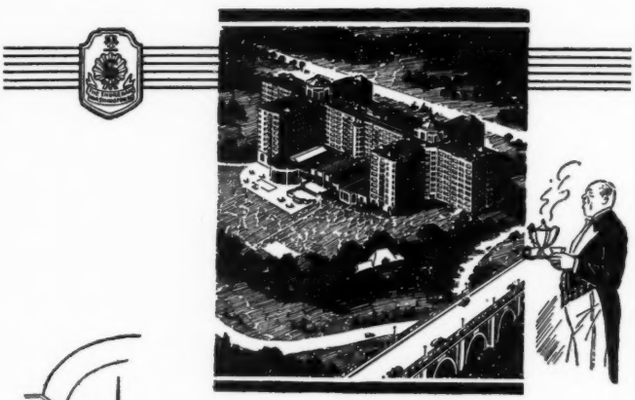

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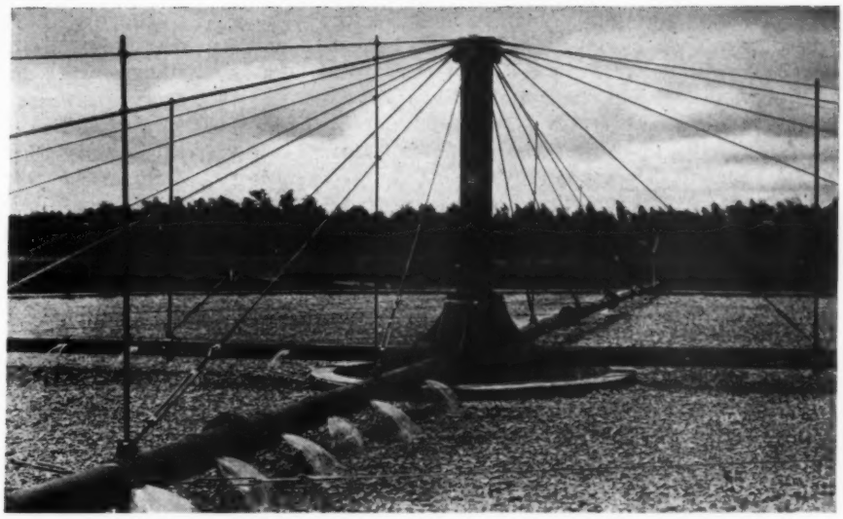
Don't forget the READERS' SERVICE DEPT.—pages 51-53

Revolving Distributors for Trickling Filters

By W. Allen Darby
Engineer, The Dorr Company



Revolving Distributor at Escanaba, Mich., on a bed 150 ft. diameter.

At present there are operating on trickling filters in the United States a considerable number of revolving reaction-propelled distributors ranging in size from very small units to those 150 ft .in diameter, which have operated successfully in the extremely cold sections of the country as well as in the warm climates. Except that the beds are round, they are built practically the same as for fixed nozzles.

Revolving distributors use less head than stationary nozzles and are usually cheaper on an installed basis. They give nearly 100% distribution, or 20% or more better than the stationary nozzles, thus permitting reducing the area of the bed. The sewage falls through the air from distributor to bed only a few inches, greatly reducing the release of odors and distortion of sprays by high winds.

The distributor mechanism consists of a stationary, cast iron or steel center column into which the sewage enters from the feed pipe connected to the center column base. The sewage passes upward through the center column and horizontally through openings into a rotating hub or outer column, which supports the arms. From the arms the sewage is distributed onto the bed through holes. The jet reaction of the sewage as it passes horizonally through the holes is the force which rotates the machine, speed of rotation varying with the head and volume of sewage discharged.

At the base of the center column, on the side opposite to the feed pipe, a drain is generally provided, the purpose of which is to permit periodic flushing of the center column and feed pipe. In some installations, the drain valve with its stem is housed in a valve box projecting to the top of the stone. In others, a well is provided around the center column and the drain valve placed in this.

Resting on the top of the inner or stationary center column is a bearing on which the mechanism rotates. Various types of bearings are used; ball bearings, roller bearings or a roller bearing with concave rollers and convex rolls. This last type is self-aligning and handles both thrust and radial loads.

The arms are supported at their inner ends on the rotating hub, and also by galvanized guy wires or rods, running from the top of the center column to the arms, generally provided with turn-buckles for easy adjustment. Guy wires are also used for lateral bracing.

Between the stationary center column and the rotating outer column, a seal is provided, of which numerous satisfactory types are in use. Some machines use an oil seal, some water, some mercury, and others a packing seal. The liquid types of seals should have a protective device against excessive surges, and the water seal requires a well at the center for clearance and must be either insulated or contain an anti-freeze mixture to prevent freezing in cold climates.

With liquid seals, the heads under which the units may be operated are limited to the capacity of the seal, but with a properly designed packed seal, the sewage may be pumped direct to the unit and with practically no danger from freezing.

Two methods are now in general use for distributing the sewage from the arms to the bed. One method is by the use of round bushed or plain holes directly to the bed, and the other by a smaller number of larger holes feeding the sewage to deflectors from which the sewage is discharged in a thin film onto the bed. The size of holes will be governed by the size of machine and amount of sewage to be handled under a given head. Normally the holes will be not less than ½" diameter nor greater than 1" diameter. Units equipped with deflectors or spreads may have fewer openings in the arms, but while the openings near the center of the machine may be about the same diameter as above, those toward the end of the arms may be the same height but be increased in length to as much as 4½". The larger the size of the holes, the less chances there are for clogging. Normally, the holes in the arms are located about 6" to 12" above the filter stone. The radial distances of the holes from the center of rotation differ on the different arms so that no two cover the same ring area.

Each arm may be provided with a drain hole in the bottom near the center of the distributor, which may be opened during cold weather to permit the arms to drain completely after each dose. At the end of each arm, near the wall, a quick opening dump gate is provided for flushing of the arm.

A dosing tank and automatic siphon are generally used with distributors operating with gravity flow. A conservative figure for the size of the dosing tank is to provide sufficient storage capacity to insure a satisfactory period of rotation based on maximum flow. Normally the siphon is designed to discharge at a rate equal to the maximum rate of flow. The dosing siphon is generally of the standard inverted bell type, and its operation is entirely automatic.

Normally, the draw-down, or difference in water levels between high and low water in dosing tanks, should be about 10″. Draw offs less than 6″ should be avoided as very close adjustments of siphons are necessary. Two to three foot draw-downs may be used, but they are objectionable, due to the great variation in discharge rates of the orifices.

In certain locations, it is necessary to pump the sewage after preliminary sedimentation. Where a plant of this type is under consideration, it may prove economical to eliminate the dosing tank and siphon and pump direct to the distributor. The operation of the distributor will be the same as if a dosing tank were used, except that intermittent operation will be supplied by the pump starting and stopping instead of siphon giving periodic dosages. If desired, the feed line to the distributor can drain back to the pump well after each dose. If this drainage is not adaptable to local conditions, a check valve can be placed in the line.

In small sewage plants, or industrial waste treatment plants located in parts of the country where severe winters are encountered, the draining of the distributor and feed pipe after each dose has proven very efficient. In such plants in many cases, little or no sewage is received during the night and early morning, when severest cold is usually experienced, and by draining the system after each dose, the freezing hazard is eliminated. Packed seals should be used in such cases.

The majority of distributors in operation at the present time have four arms for spraying the sewage onto the filter stone. Recently, however, numerous units using two arms only for distributing the sewage have gone into operation. Because of the multiplicity of round holes required in order to obtain satisfactory coverage by reducing the numbers of dry rings on the bed to a minimum, four arms have been required for this type of discharge in order to prevent crowding of holes. With large holes and spreaders for film distribution, the holes may be spaced further apart, permitting the use of two arms, with a considerable saving in cost and reduction in dead weight of mechanisms.

Generally 18″ to 30″, measured from the high water level in the dosing tank to the top of the filter medium, is ample head for operating a distributor, but the actual amount of head used varies considerably with the local conditions and the amount of flow to be handled. This small amount of head will, in many cases, permit the installation of a plant by gravity flow where this would not be practicable using stationary nozzles.

While distributors are in operation on heads of as little as 12″ or slightly less, from the center of the arms to the high water level in the dosing tank, it should be remembered that the greater the head under which a unit may operate, the more positive and clean-cut will be the performance. For this reason it is always desirable and more efficient to ultilize all of the available head.

The distributor is usually designed to handle the maximum rate of flow at the given head. In rare instances, when the maximum rate of flow is greatly in excess of the average, and the excessive flow occurs only rarely, the distributor is designed to handle some rate of flow between the average and absolute maximum. When this design is followed, sufficient freeboard should be provided in the dosing tank to provide for the backing up of sewage when the machine is handling more than the flow for which it was designed. The higher the rate of discharge selected, the longer will be the rest periods between doses. When the rate of flow to the dosing tank exceeds the discharge rate of the siphon, the distributor will go into continuous operation.

The conditions and types of sewages; ratio between minimum, average and maximum rates of flow; frequency of maximum rate; head available; etc., should be considered when designing a distributor.

When all the foregoing facts are taken into consideration and engineers appreciate the possibilities of simplified design, availability for low head localities, unformity of distribution and elimination of aerial nuisances, it is believed that the trickling filter using the revolving distributor will increase in popularity as an efficient oxidizing medium.

This article is based on a paper by Mr. Darby before the Maryland-Delaware Water & Sewage Association.

Maintenance Costs in Rhode Island

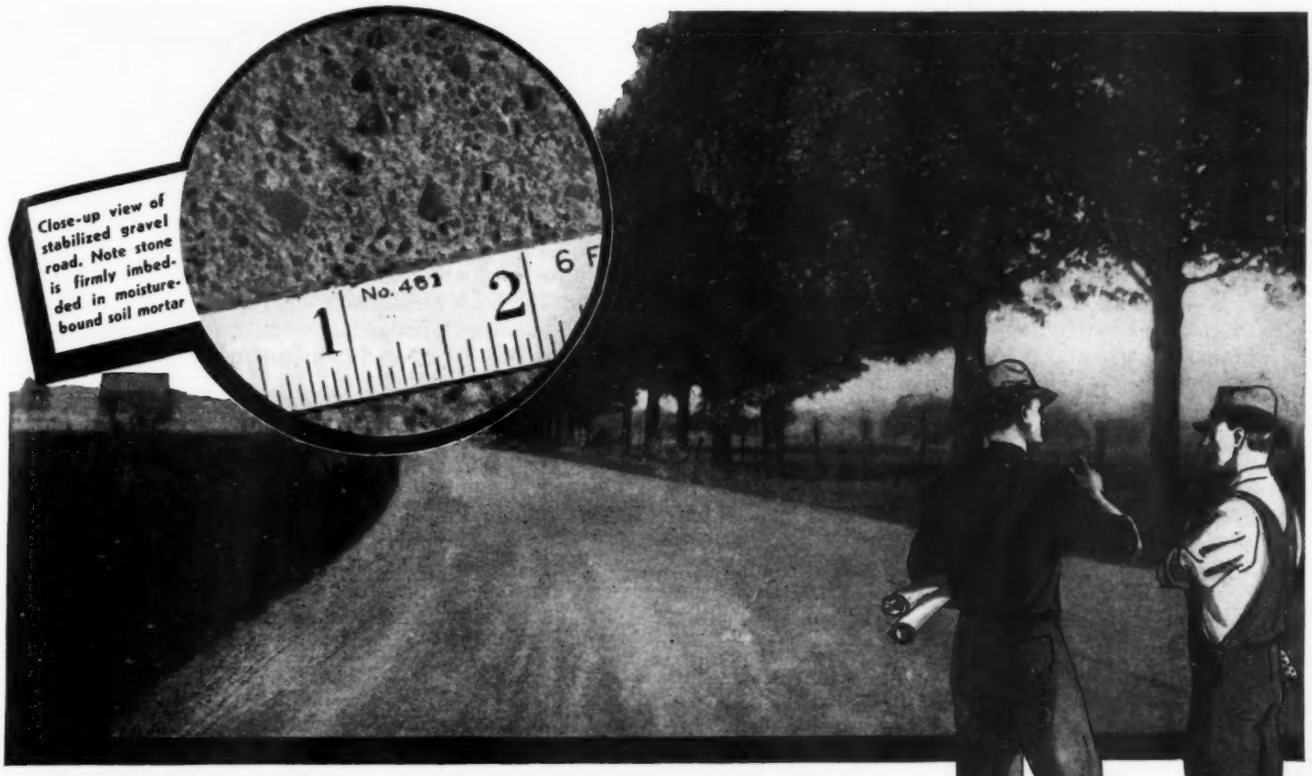
Detailed data on maintenance costs of various types of roads in Rhode Island, based on records extending back for nearly 20 years, appeared in PUBLIC WORKS for February, 1933 (page 23). The basis on which maintenance charges were made was also explained in that article. The report for the year 1933 of the State Board of Public Roads gives the following summary of maintenance costs for that year:

Type of Surface	*Miles*	*Sq. Yds.*	*Cost*	*Cost per Sq. Yd.*
Bituminous Concrete (Coarse Aggregate)	17.51	188,085	$2,026.32	$0.011
Bituminous Concrete (Graded Aggregate)	71.86	814,335	1,658.96	0.002
Bituminous Macadam (Penetration)	240.10	2,855,812	4,302.71	0.001
Bituminous Surface on Concrete Base	23.85	508,302	1,621.78	0.003
Cement Concrete	150.95	2,257,515	7,426.88	0.003
Bituminous Surface on Crushed Stone Base	1.27	21,616	0.00	0.000
Totals for State—All Classes	505.54	6,645,665	$17,036.65	$0.002

A Graphic Recording Register

In the "Water Wheel" for June is a short item referring to a statement in a paper by Thomas Hodkinson, superintendent of water works of London, Ontario, suggesting the use of a "graphic recording register" for determining the size of meter needed for a given case and for investigating complaints of high bills.

A reader of PUBLIC WORKS wrote asking where he could obtain such a register, and Mr. Hodkinson, to whom we referred the question, writes: "The Neptune Meter Co. of New York are the manufacturers of the recording register we use, and we in a way were instrumental in having this firm work out this type of register."



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CALCIUM CHLORIDE

FOR STABILIZING ROAD SURFACES

Don't forget the READERS' SERVICE DEPT.—pages 51-53

A. W. W. A.'s Successful Convention

Papers and exhibits held the hundreds of members who attended in spite of New York's counter attractions.

A TECHNICAL society can hold a successful convention in New York City—the American Water Works Association has proved it. It is a more or less commonly held opinion that the attractions of the city outside of the convention will lure away most of the members attending. The A.W.W.A.'s solution is probably the only effective one—provide counter-attractions in the convention halls and exhibition which outweigh those of the city.

The attractions certainly were there, and so were the members, about 500 of whom registered, in addition to several hundred guests. The exhibit was an excellent one, arranged most effectively to induce the members to visit it frequently, and offering plenty of objects to repay such visits.

The meetings were all well attended, some were crowded. And (take notice, you presidents and secretaries of other societies) every one began promptly on time, and with one unfortunate but apparently unavoidable exception the program was followed exactly. Only one thing we objected to (probably unreasonably)—the two-ring circus idea. Our Wednesday forenoon, for example, while Fred Nelson was explaining most interestingly and instructively the "Outstanding Factors in Underground Water Waste Surveys," Chas. Cox was describing "Equipment for the Application and Control of Chlorination in Small Water Supplies;" and later, thawing frozen service pipes and the ammonia-chlorine process were discussed simultaneously by two divisions. Which of the first two is the superintendent of a small plant supposed not to be interested in? And which of the latter two?

And, speaking of small plant superintendents, the effort made to get them to join in a "Superintendents' Round Table Discussion" was a worthy one, but as usual in this and all other societies, the result was disappointing. Not that the discussions were not interesting and valuable and well sustained—they were; but the speakers, with a very few exceptions, were not small-plant superintendents. It seems to be awfully difficult to get those modest men to tell their experiences, although some of them will ask questions, if urged.

Of the business transacted by the meeting, the first and perhaps most important was the unanimous vote that it was the belief of those present that there would be no definite benefit in a code of fair competition for the water works industry—chiefly because the units are not competitive. Even Deputy Administrator Peebles, who came from Washington to attend this discussion, limited his suggestion of possible benefits to the psychological one attached to the use of the Blue Eagle.

For the coming year, Harry E. Jordan is president of the association, and Guy C. Northrop is president of the Water Works Manufacturers Association.

The John M. Diven Memorial Award was given to Leonard P. Wood, engineer of the Board of Water Supply, New York City, for his service to the association as chairman of the sub-committee on cast iron pipe.

The Goodell prize for the best paper presented during the past year was awarded to Willard T. Chevalier for his paper "The Place of Public Works in the Economic Scheme."

The Nicholas S. Hill, Jr. Cup for the section showing the largest gain in membership during the year was awarded to the Canadian Section, which had gained 20%.

In the future there will be another cup to be awarded—the Franklin Henshaw Cup, to that section which shows the largest percentage registration at its annual meeting. Mr. Henshaw is superintendent of the Scarsdale, N. Y., waterworks.

There probably were as many opinions as there were papers read at the convention as to which of the latter were best; they were all good. But as to oratory, the choice was limited to two—Willard T. Chevalier and Abel Wolman as they presented opposite views on "Waterworks and the PWA Outlook" at the Tuesday morning session. About the only thing they agreed on was that some features of the CWA incident were unfortunate; Mr. Wolman thought that all the others were, too, while Mr. Chevalier found some offsetting advantages. The latter reported that PWA projects, though disappointingly slow in starting (partly because of political interference) showed promise of materially increasing; at which he rejoiced, and at which Mr. Wolman would have lamented if he had believed it true. For the latter believed that large Federal expenditure in times of depression may increase rather than relieve the evils thereof; while CWA aroused cupidity and destroyed pride in financial independence of both individuals and municipalities to an extent which he would have believed, a year or two ago, to have been impossible and which may remain to curse us for years to come.

It is difficult to treat of the technical papers and discussions in the limited space available here, and we will mention only a few of the points that seemed to us most interesting.

Superintendents' Round Table Discussion

Cleaning water mains is of permanent value in New York only when the mains can be recoated, as with bitumastic, which is possible only for pipes large enough to be entered. In coating these, the enamel seemed to adhere equally well on surfaces sand-blasted and those only wire brushed. Mr. Brush suggested cement-lining the smaller pipe. F. C. Hopkins, of Utica, believed the use of ammonia-chlorine treatment after cleaning prevented reappearance of tubercles.

Taste and color troubles in dead ends, as well as tubercles, are ameliorated by ammonia-chlorine, as there seemed to be evidence that both are due to biological activities in the opinion of Malcolm Pirnie and M. C. Smith.

Tanks and standpipes, or the plates for them, should be allowed to weather and rust, to remove all mill scale, before being painted, in the opinion of J. E. Gibson; Carl Hechmer would give them six months of weathering. As to risers of elevated tanks, all agreed that large unprotected ones were better than small protected ones; they were less likely to freeze and served as an important element of support for the tank. Two reported trouble from woodpeckers which not only destroyed the wooden enclosures of small risers but annoyed the neighbors in doing so.

Fire hydrant painting was utilized for giving various kinds of information, as reported by several super-

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● **Above:** *Hardened Exhaust-Valve Seat Inserts.* This feature was long ago made standard International practice These inserts retard valve seat burning, engine efficiency is retained, and the valves seldom need grinding.

● **Left:** *Replaceable Precision-Type Bearings,* another feature of International Truck engines. These bearings make it possible to replace connecting-rod or main bearings quickly, at low cost. This man is under the engine, replacing the bearings. The engine stays right in the truck.

When you visit THE WORLD'S FAIR at CHICAGO, don't fail to see the beautiful display of restyled Internationals in the Harvester Exhibit.

INTERNATIONAL TRUCKS

Don't forget the READERS' SERVICE DEPT.—pages 51-53

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intendents. In New England, the color of the top indicated the rate of expected discharge from that hydrant. In New York the size of the main feeding a hydrant is painted on the barrel. In Danvers, Mass., a red top indicates danger of water hammer if the line is closed quickly.

Discussing handling of complaints about excessive water bills, W. S. Patton recommended a conciliatory rather than a hard-boiled attitude toward consumers, usually a compromise. But E. T. Cranch said that in New York State the Public Service Commission forbids companies making any adjustment unless proved to be wrong.

Other Papers

New York's Catskill water averages 3 ppm free carbonic acid and 8 parts alkalinity. Dr. Hale reported results of two years of tests of the effects of this water on steel and iron services, both black and galvanized, brass and copper, using both hot and cold water. All the iron and steel pipes were badly tuberculated, but the brass was little affected and the copper not appreciably.

For testing friction loss in distribution pipe, two methods were described; one, by Burt B. Hodgman, for accurate testing of short lengths; the other, by Edgar K. Wilson, for testing longer lines with less, but sufficient accuracy. In the former, all valves controlling the few hundred feet to be tested are closed and their tightness tested; then a valve at one end and a hydrant at the other are opened, the flow measured by a calibrated flow meter or a pitometer, while the friction is measured by a manometer inserted in a line of garden hose connecting two hydrants in the line to be tested. Mr. Wilson's plan was for testing a long line or entire system, for which he uses Bristol recording pressure gauges, calibrated before and after each test, and numerous pitometers for measuring flow. In discussing this, Robt. E. Horton said that a logarithmic formula was being developed whereby the tuberculation resistance to flow for any age of pipe in a given system could be predicted after the constants had been learned by test, for the kind of water and pipe in the system in question.

New York City has been conducting an underground leakage survey systematically and intensively since 1931. Manhattan and the Bronx have been covered twice and a third survey is now under way, in which all services are being aquaphoned; the aquaphone being found to be the best leak finder for New York conditions. The leakage discovered and stopped has been 2½ times the most optimistic expectation, and has equaled the normal growth in consumption and permitted postponing several years the additional supply which was becoming imperative. The cost has been $2.30 per million gallons saved, based on the conservative estimate of two years' continuation of the discovered leakage at the cost of the water delivered at the city line—$45 per m. g. Mr. Brush stated, as one result of their successive surveys, that it was estimated that new leakage was continually developing in New York's system equivalent to about 10,000,000 gpd. and that they could base on this an estimate of the amount of money which could be spent economically in leak locating and stopping. J. B. Eddy of Chicago told experiences in that city; rock-filled trenches were found especially troublesome in locating leaks by aquaphone because sound carried further along the pipe than in compact soil. R. G. Yaxley said that in Waterford, N. Y., the aquaphone is used on every service by every meter reader where he reads the meter (city 100% metered) and over 90% of

the plant output is registered by service meters. Mr. Eddy recommended taking photographs of all leaks discovered, as these were more persuasive than figures in inducing councils to make appropriations for replacements of mains.

A New York attorney, W. L. Ransom, gave his opinion that, as costs have been increased and are increasing, rates should also, and this applies to municipal as well as private plants; that the former were investments by tax payers and consumers and should yield net profits, and that all costs, including overhead and depreciation, should be provided for. There is a tendency for Public Service Commissions to lower the rate of return on the allowed valuation below that which will attract capital.

The automatic pumping equipment and telephonic supervision of pumping at Baltimore was fully described (see PUBLIC WORKS for September 1932 and November 1933) by Leon Small, and telemetering in general by P. S. Wilson. An unusual feature of the former paper was the visual receipt, over a special wire from one of the Baltimore plants, of a report on the operation of that plant, made automatically.

Water Purification

The Water Purification Division in its three sessions discussed chiefly the character and use of chemicals; while in the big tent papers were read on "Coagulation with Iron Compounds," the Chicago Amebic Dysentery Outbreak, Taste and Odor Control, and what Milwaukee is doing about water purification.

In the last, J. P. Schwada told how, beginning 22 years ago, eight different reports have been received on Milwaukee's water supply, all advising filtration, and yet the people refused to authorize it, because the water is fairly pure most of the time. Several members praised Mr. Schwada for his undiscouraged efforts which finally resulted in the construction, now under way, of a 200 mgd plant to cost about 4½ million dollars, part of which will be furnished by PWA, the construction of which plant will provide about 1,900,000 man-hours of work.

Dr. A. P. Black advocated the use of iron compounds for coagulation, of which four are used—ferric sulphate, chlorinated copperas, ferrous sulphate and ferric chloride; a great advantage being the wide range of $_pH$ under which they could be used. However, R. W. Sawyer was somewhat less enthusiastic, stating that there were some conditions under which they could not be used satisfactorily.

All water supplies contain silver, but none of it will ever reach the U. S. Treasury vaults. In fact, in most waters the amount is so small that it can be detected only by the spectrographic method, described by M. M. Braidech and F. H. Emery. This consists in evaporating the water to recover the dissolved solids and burning a small amount of the residue in a small cavity in the carbon electrode of the instrument and identifying the characteristic spectrums. Examining daily samples of 24 cities for two months, these investigators found 30 elements: Silver, nickel and strontium in all; calcium, sodium, magnesium, silicon, aluminum, iron, copper, etc.; lead in appreciable amounts in Baltimore only; fluorine in alarming amounts only in Denver.

Monday afternoon was devoted to the report of the Committee on Specifications and Methods of Tests for Water Purification chemicals. The report was most comprehensive and a testimony to the enormous amount of work done by the committee, of which Mathew M. Braidech is chairman. More work in arranging, con-

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densing and editing will be necessary before it can be presented as a final report for adoption.

Floc seldom penetrates a sand bed more than 5 or 6 inches, was one item of information revealed by the investigation of the Committee on Filtering Materials; half that depth is perhaps more common with the finer sands.

The importance of chlorination was recognized by the allotment of an entire morning session to the subject, with two papers on the mechanics of chlorination, two on the ammonia-chlorine process and two on the ortho-tolidine test. Under the last topic, A. M. Buswell spoke of the interference of manganese with the test, and Roberts Hulbert of that of nitrogen, which is quite common in water supplies treated with ammonia-chlorine, and because of which the contact time after introducing ortho-tolidine should be not over 10 minutes. (See PUBLIC WORKS for June, page 21).

The Water Wheel

(Continued from page 28)

Asbestos cement pipe ("Transite") is composed of a mixture of asbestos fibre and portland cement, formed under high pressure into a dense, homogeneous structure.[A7-4] The asbestos fibres are analogous in effect to steel reinforcement, but uniformly and closely distributed. It is made in 5 pressure classes up to 500′. Advantages: freedom from tuberculation, soil electrolysis and joint leakage, light weight, no necessity for caulking or bellholes. Unit strengths used, 3,000 lb. tensile and 10,000 lb. compressive; each pipe tested hydrostatically to double the working pressure. Joints made with "Simplex" coupling—tight, flexible, allowing 12° angularity at each joint. Prof. W. S. Pardoe said his tests indicate this pipe "will discharge 15% more than clean cast iron and 45% more than slightly tuberculated cast iron pipe." The pipe can be cut with a hack saw or well-set wood saw.

Meters should be *inspected* annually by investigators other than meter readers. Routine tests of all meters should be made at least once in 5 or 6 years, and of the larger sizes more often. Size of meter should correspond to amount used through it, checking this from time to time. (Too large meters fail to register low flows.) Meters should be placed as near as possible to the street main, so that consumer pays for leaks in his service pipe. Hartford, Conn., will not place a meter more than 75 ft. from the street main. These are conclusions from a study of about ten thousand meters in the Hartford Metropolitan District.[F7-3 & 9]

Sterilizing meters when installing them is recommended by G. R. Fulton,[DD7-4] the line side of the meter connection receiving a tablespoon of calcium hypochlorite before installing the meter, and when connection has been made, faucets allowed to run until evidence of chlorine is found, and pipes then stand full without use for at least an hour.

Pump sizes selected for small plants are often uneconomically large.[DD7-15] Pumps operate at partial loads with low efficiencies, giving high power costs and possibly excess demand charges. Except for very low requirements, it is often economical to install pumps of different sizes so that, by use of one or more, fluctuations in demand can be met with pumps operating at their most efficient capacity. If storage is available for at least six hours' consumption, pumping can be maintained at maximum efficiency at all times.

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Construction and Maintenance Equipment

A Fast Roller:

A new fast, light roller of great mobility and short turning radius—the Warrior—has been announced by Galion. It is a 3-wheel roller, built in 5, 6, 7 and 8-ton sizes. The 5 and 6-ton units are described in Leaflet 167, issued by the Galion Iron Works & Mfg. Co., Galion, O. Speeds are from 1.69 mph in low, up to 5.90 in high. Through governor control, speeds as low as 0.85 mph can be obtained. The rear rolls are 18 inches wide and 55 in diameter. Equipped with scarifier, if desired; all models have 50-gallon sprinkling tank, but tanks up to 250 gallons can be furnished. The 7 and 8-ton units are described in Leaflet 166. Full information from the Editor of PUBLIC WORKS or from Universal Road Machinery Co., Kingston, N. Y. Folder on request.

Galion Fast Light Roller

Highway Sweeper for Low Cost Road Construction:

This is a truck or tractor-drawn unit of modern design for removing dust from highways prior to the application of bituminous materials. It is mounted on 3 rubber-tired wheels, which gives a 3-point suspension, easy to steer and to turn. It has anti-friction bearings, and a new, quick method for raising and lowering the broom.

Sweeping of highways is necessary before applying bituminous material on many types of low cost road construction. This sweeper is especially adapted for satisfactory and economical work.

"Cat" Diesel Auto Patrol:

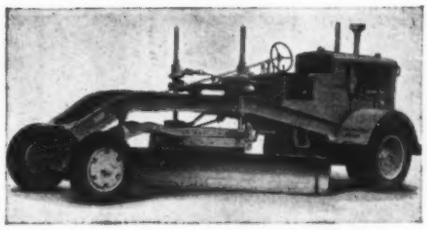
The "Caterpillar" Diesel Auto Patrol is announced by Caterpillar Tractor Co. of Peoria, Illinois. Neither unit is new, as the 3-cylinder, 4-cycle Diesel engine has been used in the Diesel Thirty Five Tractors and power units, and the Auto Patrol was first introduced nearly three years ago.

The engine develops 47 maximum brake horsepower at governed speed of 850 r.p.m., and the machine has a shipping weight of 15,510 pounds. Such well-known features as full power control of all blade adjustments, rear mounted engine, positive drive to dual rear wheels, elimination of the differential, four forward speeds ranging from 1.8 to 10 miles per hour, heavy structural steel circle and extra wide 12-foot blade equipped with end bits, adapt the machine to all kinds of maintenance work, including regrading and snow plowing, as well as many surfacing jobs including subgrading and oil-mix work. Power operated scarifier and snow plow are available as special equipment.

A New Concrete Mixer By an Old Company:

The Koehring Company has developed a new 10-S Dandie Trail-Mix, having all the superior features of the recently announced four wheel type 10-S Dandie Mixer.

The charging skip of the Dandie Trail-Mix is free from obstruction at the front and side, permitting convenient and fast loading. The machine has the Koehring automatic skip-flow shaker which actuates the skip up and down, causing shaking along the natural flow-line of the material.



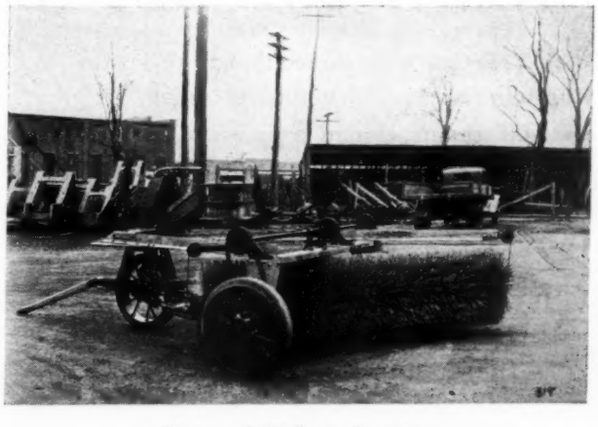
Caterpillar Diesel Auto Patrol

10-S Dandie Trail-Mix

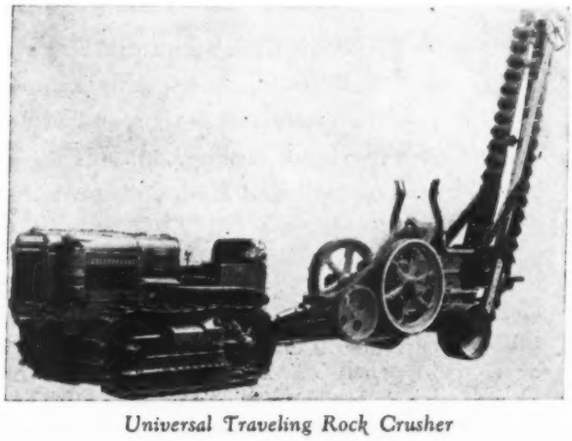
Anti-friction bearings, V Belt drive, automotive type steering, full-floating spring mounting, are a few of important advantages to be had in this modern machine.

Traveling Rock Crusher With Tractor:

A complete, portable, rock crushing and handling plant, including elevator, crusher, chute screen and drive, all mounted on a 2-wheel trailer truck, ready to operate. It can be furnished with or without tractor. Drive is by power take-off from the tractor. When an elevator is not used, this plant can be moved along the road without stopping the crusher, which allows stone walls, for instance, to be crushed without hauling. Also, very convenient to move from place to place for small jobs. This plant is made by Universal Road Machinery Co., Kingston, N. Y.



Universal Highway Sweeper



Universal Traveling Rock Crusher

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Collingswood, N. J., activated sludge plant (Remington, Vosbury & Goff, Consulting Engineers). Two primary settling tanks with Link-Belt Straightline Collectors, in extreme background. Four aeration tanks with Link-Belt Straightline Mechanical Aerators, in center; and four final settling tanks with Link-Belt Straightline Collectors, in foreground. The clearness of the effluent is indicated by the reflection in the tanks.

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Don't forget the READERS' SERVICE DEPT.—pages 51-53

New and Interesting Developments

Bituminous Heater Mounted on Truck

By mounting an oil burning boiler on a high speed truck, C'eaver-Brooks Company, Milwaukee, has worked out a new idea in portable steam heating plants for heating tank cars of bituminous materials, thawing culverts and manhole covers in winter, steam cleaning machinery, and for various other purposes. Advantages are unusually fast steaming and extreme portability.

The first of these units was developed in cooperation with a contractor who received the largest contract for applying bituminous material ever let in this country. This work is being done in Pennsylvania, New York and Maryland and a fleet of these units have been ordered for the work.

The oil burning units have large storage tanks for water and fuel oil. From a cold water start they develop full working steam pressure in 30 minutes,

Cleaver-Brooks Heater Unit

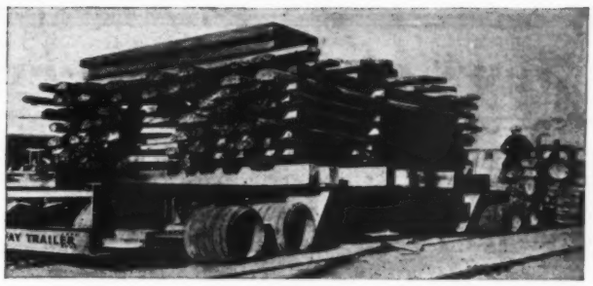
have exceptionally high efficiency and control'ed heating capacity. Previously, these units have been trailer mounted.

Proportional Chlorinator on Standard Water Meter

The essential principle in this unit is that the flow of water controls the dosage of chlorine solution. The Chlor-o-Feeder operates with any flow-responsive device, such as a standard water meter, venturi meter, orifice plates, constant speed motor, or even the reciprocating parts of deep well pumps.

This equipment should be of great value in giving accurate dosages on varying flows of water, and a test in Connecticut revealed no detectable differences in 15 samples taken at various times of day. It may be attached to the top of a standard ¾-inch water meter and set to give any dosage to the water passing through the meter. In such an installation it requires no outside source of power. However, it is a!so furnished connected to a very small electric motor, as shown in the portable outfit illustrated.

This low-cost outfit is more fully described in a circular which will be sent on request to Proportioneers, 9 Codding St., Providence, R. I.



Goodyear tire - equipped LaCrosse trailer hauling a load of 235 tons

Penstock Pipe at Boulder Dam Moved on Giant Trailer

After the completion of a severe test at Boulder City, a giant trailer for carrying the great penstock pipe from the fabricating plant to Boulder Dam has been pronounced satisfactory by government and Six Companies, Inc., engineers.

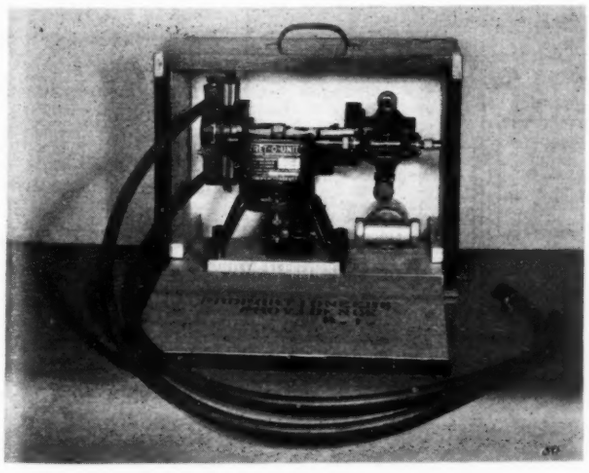
The trailer, sold by the C. R. Jahn Company of Chicago and built by the La Crosse Trailer Co. of La Crosse, Wisconsin, is the largest ever built. It is 37 ft. 8 inches long and 22 ft. wide, with frame built up on two 33-inch beams. It is mounted on 16 wheels supported by eight axles, each with two Goodyear tires to the wheel, making 32, 28 x 14 tires.

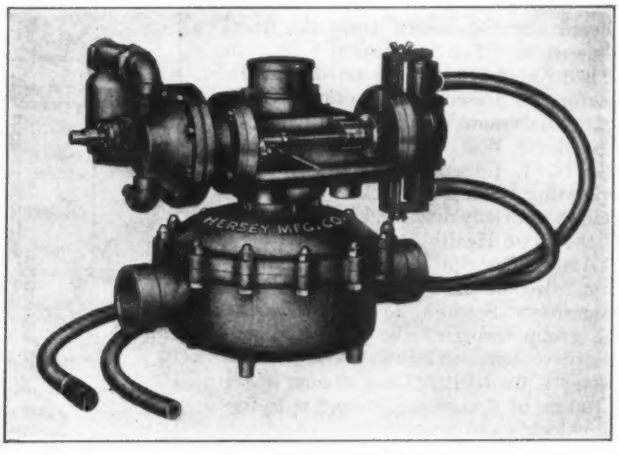
All 16 wheels are steered by hydraulic pressure. Pressure is furnished by a Northern Nytroalloy steel pump driven by a 15 HP motor. Control is provided by a steering wheel on a platform at one end of the trailer. A compensating link between the two main steering levers makes it possible to steer the wheels on the inner arc of a curve at an angle suitable to the angle of the wheels on the outer arc and assure a rolling action to all 16 wheels.

Hauling may be done from either end and drawbars are provided. Thus the trailer does not need to be turned around at the end of the trip.

The test of this unit consisted of loading the trailer with 194 tons of reenforcing rods. The trailer weighs 41 tons, making the gross load almost 235 tons. The trailer and its load was then pulled over a roundabout road to the highway. This necessitated crossing tracks and rough terrain.

The delivery of the pipe to the dam has been one of the major problems confronting the government and the Six Companies engineers. Some of this pipe is the largest ever built, weighs 185 tons, and is 30 ft. in diameter—almost four stories high. It is 2¾-in. thick and made of six plates of steel, so heavy that on'y three plates make a load for one flat car from the steel mill to the fabricating plant. The trailer and this great load must travel over a road 1½ miles long, blasted out of the mountain side, to the dam site where it will be unloaded by the permanent government cableway and lowered to the penstocks hundreds of feet below.





At the left, the Proportioneers' portable chlorinator, at the right a feeder mounted on a standard water meter

News of the Engineering Field

New York State Sewage Works Ass'n Honor Holmes and Skinner:

This association held its spring meeting at the Hotel Jamestown in Jamestown, New York, June 15-16, President E. B. Besselievre presiding. One hundred and seven members and guests were registered; nineteen manufacturers had exhibits.

The convention opened with a brief business meeting and the presentation of two technical papers Friday morning. Henry Ryon, Sanitary Engineer of the State Dep't of Public Works described the activated sludge plant at the Harlem Valley State Hospital, a very compact plant utilizing Simplex aerators and many automatic mechanical devices. Discussion was opened by E. M. Jones of the Simplex Valve & Meter Co. and W. B. Marshall of the Chain Belt Co. "Present Aspects of Chemical Treatment of Sewage & Sludge" by J. H. Brendlen of the Calco Chemical Co. was discussed by L. L. Hedgepeth of the Penn Salt Co., and was followed by many questions from the floor.

At the luncheon, the Hon. Leon F. Roberts, Mayor of Jamestown welcomed the convention to Jamestown.

Five papers were presented at the afternoon session. A. E. Stilson of the Morse Boulger Destructor Company presented a paper on the "Disposal of Sewage Solids by Incineration," illustrated by lantern slides and charts. Discussion followed by Wm. Raisch of the Municipal Sanitary Service Corporation and by W. H. Pitkin of the Oliver United Filter Corporation. Thomas Houbi's paper, "Sewage Treatment at Fredonia," was discussed by A. F. Allen, District Engineer of the State Health Department at Buffalo, who also spoke of recent operating difficulties in handling acid iron wastes at several of the sewage treatment works in the Buffalo area. Earl Devendorf, Associate Director of the Division of Sanitation in the State Health Department spoke on the "Status of Federal Aid for Sewerage and Sewage Treatment in New York State" and answered many questions from the floor. A paper on "The Mechanical Filtration of Elutriated Sludge" prepared by C. E. Keefer and presented by Herman Kratz, Jr., of Baltimore was discussed by E. B. Besselievre. Wm. Gavin Taylor of Newark, N. J. presented an "Abstract of Operating Results at Rockville Centre," which was briefly discussed by C. C. Agar of the State Health Department.

After a description by Leland L. Graham, director of Public Works, of the Jamestown Sewage Treatment works, the group inspected the plant and witnessed a demonstration, set up by the Oliver United Filter Corporation, of the filtration of sludge conditioned with ferric chloride and lime.

The association passed a resolution honoring John F. Skinner who recently retired after more than forty years of service as sanitary engineer of Rochester, N. Y., and another resolution honoring Glenn D. Holmer, who has retired as chief engineer of the Syracuse Intercepting Sewer Commission.

The fall meeting of the Association will be held at Oneonta early in October.

Oil-Engine-Driven Portable Air Compressors:

Ingersoll-Rand has recently doubled its line of two-stage, air-cooled portable air compressors. All six sizes are now available with oil-engine drive, as well as with gasoline-engine drive.

The oil engine starts easily with a hand crank and operates smoothly, with invisible exhaust. It has high torque at reduced speeds, giving it the "lugging" ability of a steam engine.

One of the great advantages of the oil-engine drive is the fuel-cost saving resulting from the use of inexpensive non-explosive fuel oils, such as household furnace oil, etc.

The six sizes of the two-stage, air-cooled portable compressor have respective capacities of 75, 125, 185, 250, 370, and 500 cfm. (either gasoline or oil-engine driven). Both are described in Bulletin No. 2100, which can be obtained from Ingersoll-Rand Co., 11 Broadway, New York, or from any branch office.

Porcelain Pump Impellers Save 10% on Power:

Vitreous porcelain enamel applied to the entire surface of pump impellers and bowls protects these parts against erosion, electrolysis and oxidation. Not only is protection obtained but much lower frictional losses result from the use of this smooth and chip-proof surface. A saving of approximately 10% on power is claimed. Information is available from

Ingersoll-Rand Two-Stage air-cooled portable air compressors

PUBLIC WORKS, or from Johnston Pump Co., 2324 E. 49th St., Los Angeles, Calif.

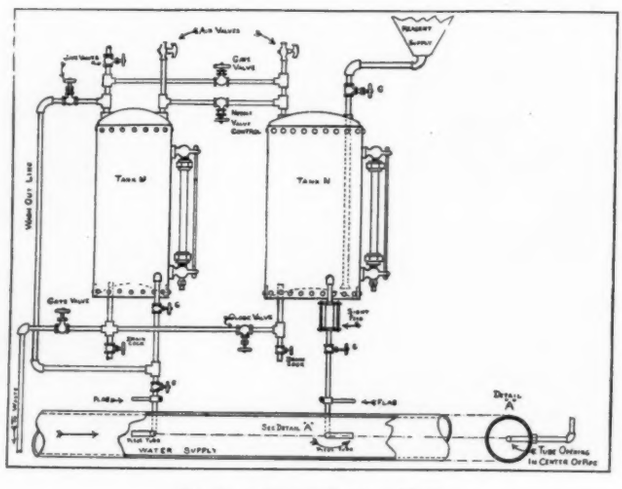
Handy Floodlights for Night Work:

While especially designed for fire use, the new GE Handy floodlights have a field application in all night work. They are small, with a stable base, and can be adjusted quickly to project the light beam in any direction. They are especially applicable to apparatus and equipment with electric generators.

A New Proportioning Unit for Water Treatment:

D. W. Haering & Company, Inc., 3408 Monroe Street, Chicago, Illinois, announce the H-O-H Proportioning Unit, an automatic proportioning machine which makes the accuracy of the pitot tube principle practical for the first time.

This machine will feed liquid chemicals into liquid lines under varying conditions of pressure and in any amounts desired. The machine is entirely automatic. It starts, stops and feeds in proportion to flow. The only manual attention required is the recharging of the unit which may be accomplished in less than five minutes and the reagent tanks are made of sufficient size to require this operation only at long intervals.



Haering Proportioning Unit

The machine is finished in baked enamel and sells at a very low price, setting new records of economy in the proportioning equipment field. It is also easy to install as it is only necessary to drill and tap 3/8" holes in the pipe line in order to install the pitot tubes. Once the tubes are installed it is possible to disconnect the machine and make all piping arrangements or changes from time to time without interfering with the main flow of liquid. See illustration.

tables and data for the water works man on pipe line construction, weights, and dimensions. 40 pages, handy pocket size. United States Pipe & Foundry Co., Burlington, N. J.

Pipe Forms

409. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Taste and Odor Control

411. How, when and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a new booklet just issued by Industrial Chemical Sales Co., Inc., 230 Park Ave., New York, N. Y. 32 pages, table, illustrations and usable data.

412. Cliff-Char, a Superior Activated Carbon, for Water Purification. Exceptionally high in phenol adsorption, deodorizing power, taste adsorption, clarifying power. Full information will be sent by Chemical Dept., The Cleveland-Cliffs Iron Co., Union Trust Building, Cleveland, Ohio.

Pumping Engines

413. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Screens, Sewage

417. The simple, automatic Loughlin self-cleaning traveling screen is fully described in a new bulletin just issued by Filtration Equipment Co., 350 Madison Ave., New York, N. Y.

418. Sewage screens (Tark, Brunotte, and Straightline) for fine and coarse sewage; Straightline Collectors for Settling Tanks (Sludge, Scum and Grit), and Mechanical Aerators for activated sludge plants. Link-Belt Company, 910 So. Michigan Ave., Chicago, Ill. Book 642.

419. An illustrated booklet showing installations, and complete details regarding the 19 exclusive improvements which are featured in Shevlin Fine Disc Screens will be sent promptly by the Shevlin Engineering Co., Inc., 227 Fulton St., New York, N. Y.

420. A useful new bulletin for all those interested in sewage disposal, describing some of their proven equipment such as self-cleaning bar screens, grit conveyors, sludge collectors and shredders, has just been issued by the Jeffrey Mfg. Co., Columbus, Ohio. Includes diagrams and many illustrations.

Screens

424. Water Screen Book No. 1252, describes water screens and gives complete technical information about them. Link-Belt Co., Chicago, Ill.

Sludge Bed Glass Covers

426. Sludge Bed Glass Covers—"Super-Frame." Hitchings & Co., Main Office, Elizabeth, New Jersey. Offer A. I. A. File 101SB, describing glass covers for sludge and sprinkler beds; details, specifications and cost data.

Sludge Conditioning

382. Full information concerning the experiences in the use of ferric chloride for use in sludge conditioning and in coagulating sewage will be sent promptly by Innis, Speiden & Co., 117 Liberty St., New York, N. Y.

Treatment

429. A new series of bulletins describing their full line of sewage treatment equipment—Fine Screens, Schofield Bar Screens, Vacuum Filters for Sewage Sludge, Decarie Screenings Incinerators, Schofield Bar and Fine Screens, Vacuum Filters for Sewage Filtration and Pneumatic Ejectors for Sewage Screenings—are ready for distribution on request to Municipal Sanitary Service Corp., Room 2703, 155 East 44th St., New York, N. Y.

430. Separate bulletins showing their many lines of sewage treatment equipment will be sent promptly by The Pacific Flush Tank Co., Chicago and New York. The latest is No. 110 describing tray clarifiers.

431. Eliminate sludge bed troubles, forget about weather conditions, odor nuisance, hail insurance and the like. Full details as to how Oliver United Vacuum Filters overcome these problems will be sent to all interested by Oliver United Filters, Inc., 33 West 42nd St., New York, N. Y.

433. Collectors and concentrators for modern sewage treatment plants, recent installations, and full data on aerators, and screens. Link-Belt Co., 910 So. Michigan Ave., Chicago, Ill., and Philadelphia.

Road and Street Maintenance

Asphalt Heaters

8. Full information concerning their tar and asphalt kettles, surface heaters, oil burners and other road maintenance equipment will be sent promptly on request by Littleford Bros., 452 East Pearl St., Cincinnati, Ohio.

200. For general construction and maintenance, the Original Improved "Hotstuf" Asphalt Heater, an economical oil burning heater. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Bituminous Materials

225. A comprehensive manual on the "Use of Emulsions for Street and Highway Construction and Maintenance," discussing types, uses, relative costs, construction details, etc., will be sent promptly on request by Headley Asphalt Division, Sinclair Refining Co., P. O. Box 71, Marcus Hook, Penna.

226. "Asphalt Surfacing Materials for Low-Cost Roads" is a handy, 28-page booklet illustrating the many types of road surfaces which can be constructed with Texaco asphalt materials. Well illustrated and contains tables of amounts of stone, sand and asphalt required. Sent promptly by the Texas Company, 135 East 42nd St., New York, N. Y.

227. "Asphalt for Every Purpose," a 44-page illustrated booklet describing Stanolind Asphalt products. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

228. A new booklet has just been issued by The Barrett Co., 40 Rector St., New York, describing and illustrating the uses of each grade of Tarvia and Tarvialithic. 32 excellent illustrations.

229. A new series of concise and authoritative manuals of construction covering the latest developments in road-mix and surface treatment types as well as the standard asphalt pavements. These contain the best that has been developed by study, research and practical application in all types. Manual 1—Road-Mix Types is now ready for distribution. The Asphalt Institute, 801 Second Ave., New York, N. Y.

229A. Surface Treatment Types, Asphalt Road Construction Manual No. 2. Full details on surface treatments. 14 chapters, 128 pages. The second of those tremendously valuable and handy little manuals put out by the Asphalt Institute, 801 Second Avenue, N. Y. Sent on request.

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For the Engineer's Library

The editors will be glad to assist readers in getting copies of publications mentioned here.

Manual of Financial and Accounting Procedure for Public Bodies:

The staff of Public Administration Service has prepared for the Federal Public Works Administration a manual which sets forth the method of estimating public works projects, the basis of grants, and complete instructions for the handling of PWA funds. It also sets forth complete project accounting and cost procedure for construction use. Public Administration Service, 850 East 58th St., Chicago, Ill.

What is the NRA?

The National Recovery Administration has just published a 30-page booklet covering the aims, methods and accomplishments of the NRA. Write the National Recovery Administration, Washington, D. C.

Bubonic Plague:

Rats are the primary carriers of bubonic plague, the "black death" of the ancients and a disease now causing 3000 to 4000 deaths monthly in India. Fleas transmit the disease from rats to certain other rodents and to man. An article in the Weekly Bulletin of the California Department of Health tells something of this disease and also of the focus of infection which has been established in the west among the ground squirrels of that region.

More About Stabilization:

"How to Maintain Roads with Dowflake" is a new bulletin or booklet issued by the Dow Chemical Co., Midland, Mich. A letter will bring complete information on latest approved methods of testing and proportioning natural soil materials and how to combine them into a road.

Small Septic Tanks:

Septic tanks of copper-bearing steel, protected by mineral asphalt, in capacities up to 5,000 gallons, are described in a bulletin issued by San-Equip, Syracuse, N. Y. A new type of horizontal flow tank of small capacity, giving longer travel of sewage, is described. Considerable worth-while information on final disposal by subsoil seepage.

Hydraulic Dredges:

An interesting 36-page bulletin on dredging plants and hydraulic dredge machinery outlines the various types of hydraulic dredges and their applications, discusses the special advantages of hydraulic dredging plants and explains in detail the types of equipment used on hydraulic dredges and the factors that determine the selection of a dredge for any given kind of work. The bulletin describes instances of the performance and operating records of the hydraulic type of dredge on various classes of standard and special work. A section is devoted to installation and operating suggestions for best results, and considerable engineering data is also included. Copies of the bulletin may be obtained by addressing Morris Machine Works, Baldwinsville, New York, and mentioning Bulletin 151.

Selection of Cable:

A new 80-page reference book on "How to Select Insulated Cable" has been published by the General Electric Company, Schenectady, N. Y. Designated as GEA-1837, the publication covers cable for the transmission and distribution of electric power at normal frequencies and presents in convenient form the information that is required in determining the cable best adapted for a particular installation.

Two methods of selecting conductor size are given. The first, a comparatively simple one, covers cable for wiring houses, buildings, small industrial plants and similar applications. The other method, more detailed, includes 27 tables of current-carrying capacities.

Super DeLavaud Pipe:

A new catalog on super DeLavaud pipe has been issued by the James B. Clow & Sons, Chicago, Ill., and the National Cast Iron Pipe Co., Birmingham, Alabama. This catalog gives in condensed form a lot of information about this new type of pipe. Complete specifications, tables of weights and dimensions. Copy on request to the Editor of PUBLIC WORKS, or to either of the above companies.

Transite Pipe:

Composed of a mixture of asbestos fibre and portland cement, formed under high pressure, transite pipe is recommended by the Johns-Manville Co., N. Y., for heads up to 500 feet of water. It is stated to be proof against tuberculation, soil corrosion and electrolysis. Specifications, weights, dimensions, prices and flow data are included in a 20-page booklet. Sent free.

Monobloc Centrifugal Pumps:

An 8-page bulletin in describing the new Worthington Monobloc centrifugal. Rating tables; example to show method of selecting a pump is interesting; dimensions of these pumps; table showing friction of water in pipes, 10 to 280 gpm, 1″ to 4″ pipe. Worthington Pump and Machinery Corp., Harrison, N. J.

CIVIL ENGINEERING HANDBOOK By Leonard C. Urquhart, Editor in Chief 10 contributing Editors. First edition. 88[illegible] pages. 647 illustrations. McGraw-Hill Book Co., N. Y. $5.

This handbook aims to present in one volume the fundamentals of the various subdivisions of civil engineering in such a manner that practicing engineers can make use of the data when confronted with a problem outside of a specialized field. It does this well. Mechanically, it is a departure from the usual handbook. The type is large—in fact, just about the size used in this review. The page is larger, the type page being 4½ by 7 inches.

SURVEYING, by Raymond E. Davis, covers 83 pages, and in this space treats the subject well: RAILWAY and HIGHWAY ENGINEERING is by John B. Babcock, 3rd, and takes an even 100 pages; MECHANICS OF MATERIALS, by Jesse B. Kommers, 85 pages; HYDRAULICS, by Horace W. King, 89 pages; STRESSES IN FRAMED STRUCTURES, by Leonard C. Urquhart, 107 pages; STEEL DESIGN, by Carlton T. Bishop, 77 pages; CONCRETE, by S. C. Hollister, 90 pages; FOUNDATIONS, by Clement C. Williams, 83 pages; SEWERAGE AND SEWAGE DISPOSAL, by Richard G. Tyler, 73 pages; WATER SUPPLY AND PURIFICATION, by Harold E. Babbitt, 77 pages.

All of the contributors, and the editor as well, are professors and it is but natural that many or most of the sections are so arranged that they can be used as a text for undergraduate courses. There are frequent cross-references between sections, and fairly good bibliographies are found at the ends of the sections.

This is a good book; the subject matter is well treated; and it is up-to-date.

Material Prices

(June 23, 1934)

Prices on cast iron pipe, net per ton, Class B, 6-inch and larger, AWWA specifications*

Boston	$47.50	Baltimore	$45.50
New York	44.90	Atlanta	42.00
Chicago	46.00	Birmingham	38.00
Minneapolis	48.50	Kansas City	48.15

Burlington, N. J., $42.00; extra price for 4-inch, $3.00 per ton; extra for class A. $3.00 per ton.

**Information, courtesy U. S. Pipe & Foundry Co.*

Warehouse Prices on Reinforcing Steel and Structural Shapes

	Structural Shapes	*New Billet Reinforcing Bar*
New York	3.42c	—
Boston	3.42	—
St. Louis	3.49	—
Cincinnati	3.45	3.10
Pittsburgh	3.20	3.00
Chicago	3.25	—
Philadelphia	3.00	2.955
Cleveland	3.36	2.10
San Francisco	3.55	3.50

Warehouse Prices on American Pig Lead

New York	4.75 to 5.75
Cleveland	5.00 to 5.25